COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

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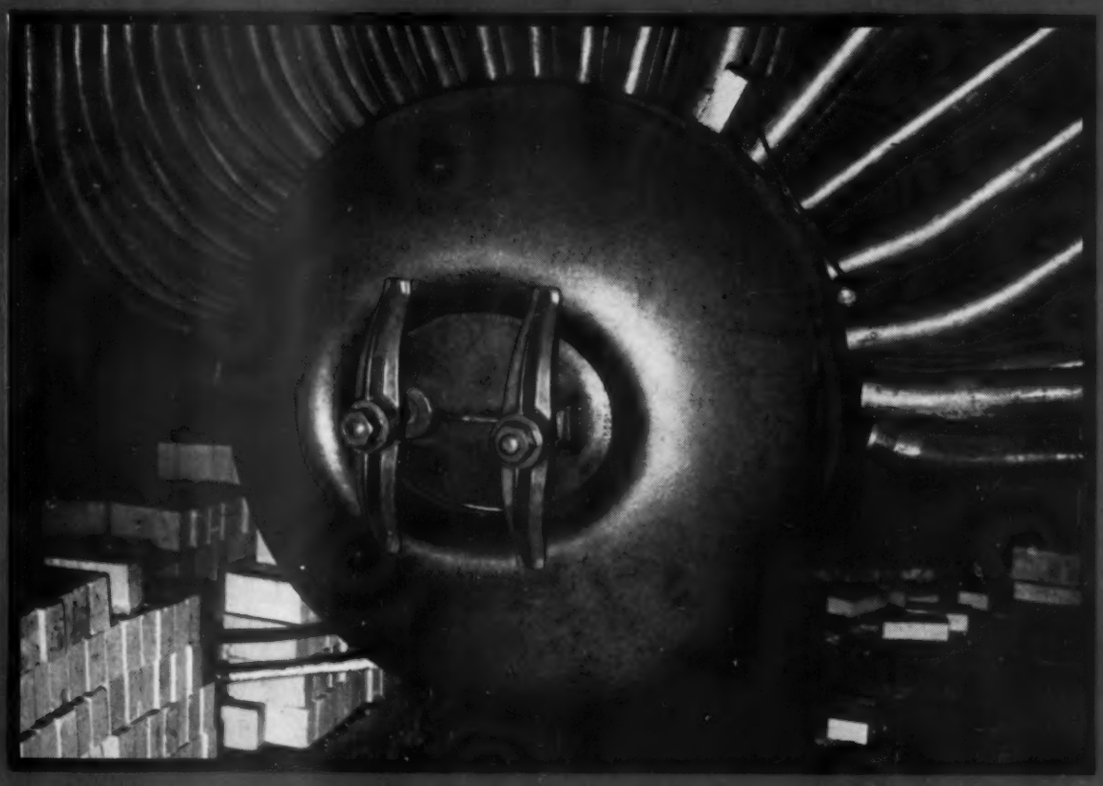
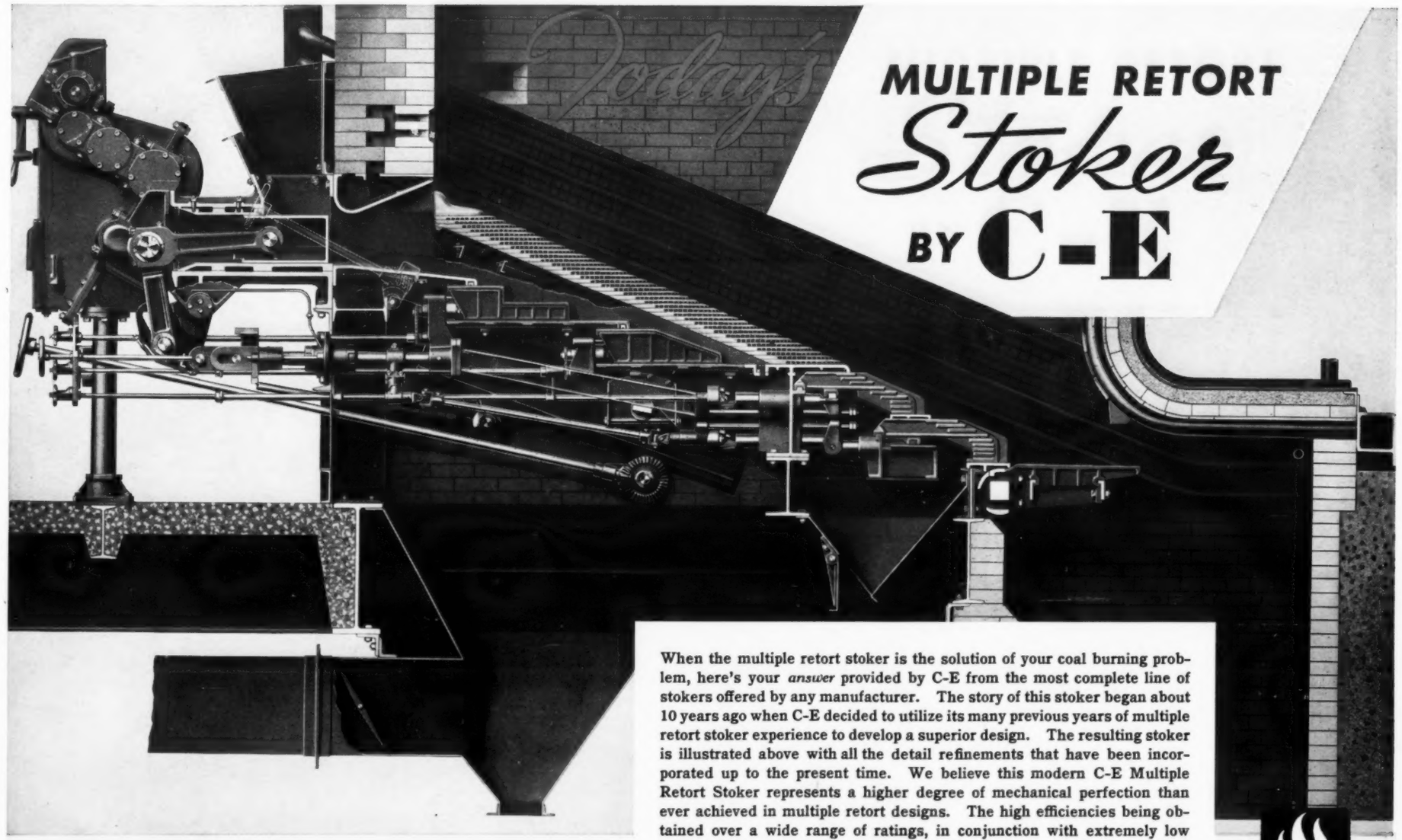


Steam Generating Units at Argentine Sugar Plant

Waste-Heat Boilers

Operation of Centrifugal Boiler-Feed Pumps

Boiler Embrittlement Protection



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COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

VOLUME TWELVE NUMBER SEVEN

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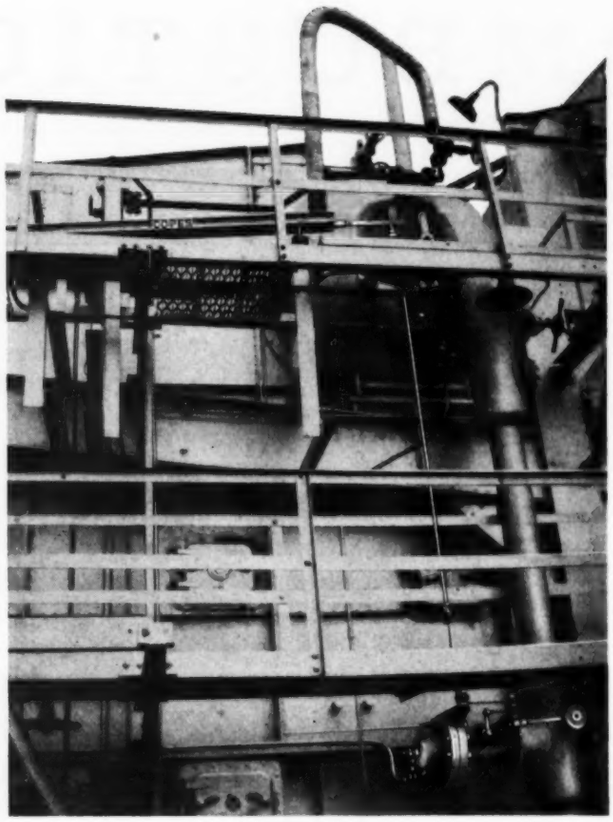

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EDITORIAL

Designing for the Emergency

It is generally conceded that the design of an industrial power plant, supplying both power and process steam. may present a more complicated problem than that of a central station, despite its lesser magnitude. This is because of factors governing relative steam and power demands which are beyond the control of the power engineer, and which may render the operating heat balance uncertain. There are also to be considered possible changes in manufacturing processes, due to research and development or to changes in business conditions during the life of the equipment.

With this true of normal times, what of the present situation when no one can foretell what the next twelve months may bring forth—not alone as to increased power demands but, for many plants, a radical change in the character of the manufactured products. Even if this country is fortunate enough to escape being drawn directly into the present conflict, it is quite apparent from the President's latest message that industry will be placed on an essentially wartime basis in order to strengthen our own defenses and to extend all possible aid to Great Britain. This dislocation of normal production will be reflected in the power plant field.

It is impossible to forecast how long the emergency may last, or what the economic situation will be in this country when it is over. Where new power facilities are concerned wholly with munitions plants the problem of the designer is relatively simple; but where existing establishments are to be expanded to handle further Government orders along with the manufacture of commercial products, in the expectation that the added facilities will later serve peacetime manufacture, the consulting engineer's problem is rendered difficult.

In meeting this situation the present disposition, among designers of industrial power plants, seems to be to disregard innovations in favor of steam conditions and well-tried designs that will assure maximum reliability, earliest possible delivery and proved performance.

Large Petroleum Production

According to the American Petroleum Institute, more oil was produced, more refined products were manufactured, and more petroleum products consumed in the United States last year than ever before in the eighty-year history of the petroleum industry. Despite this, underground oil-reserve inventories are said to be greater than at any previous time.

The effects of the war in Europe were contrary to the predictions of many in that petroleum exports declined materially from those of 1939, and the latter part of 1940 found a large number of tankers tied up. The fall of France and other Continental countries had much to do with this situation. Thus it would appear that domestic consumption was responsible for the record production; light fuel oils for domestic heating having increased eighteen per cent and motor fuel six per cent.

Had it not been for present refining processes, which permit controlling at will the proportionate amounts of various products extracted from the crude, the unprecedented demand for the lighter oils would have made available vast quantities of heaver boiler oil which would have been reflected in lower prices.

Lacking this price incentive, there was a marked swing to coal, for both stoker and pulverized-coal firing, among the power boilers that went into service or were ordered during 1940, excepting of course, certain sections of the country that have long been predominately oil or gas burning.

St. Lawrence Power

In a press release, John D. Battle, executive secretary of the National Coal Association, says:

"Congress will not have far to seek for proof that the St. Lawrence hydroelectric power facilities, upon which the President is so insistent, will cost twice as much and take three times as long to get ready as coal-burning electric-generating plants of equivalent capacity. The steam plant now being built for national defense by the TVA affords a striking object lesson, and since it is a Government enterprise, it is a *yardstick* that the Administration cannot disavow.

"The TVA steam plant, started last August, will be finished and in operation next December, or sooner. It will have cost ten million dollars and have a capacity of 120,000 kw.

"The time to complete the St. Lawrence project and its overall cost are debatable questions, but at the earliest it would be three or four years before any electric power became available. The New York Power Authority, a state agency borrowing on the State's credit, is to be called upon to chip in ninety million dollars as its share in the enterprise.

"The New York Power Authority, if so minded, could build a series of strategically located steam plants with a total capacity equal to that of the St. Lawrence for 68 million dollars, as compared with the 90 million budgeted as one (and only one) of the items in this half-a-billion dollar St. Lawrence scheme. Aside from this initial saving the new increment of electric power, which the Administration asserts is so needful for national defense, would become available early in 1942 instead of late in 1944."

The logic of Mr. Battle's contention is undeniable, but under the stress of present conditions and the existing temper of Congress the chances seem to favor this long-disputed project, despite its many uneconomic features. Furthermore, judging by reports of the vast amount of private steam generating capacity now under construction, on order or projected, there is every assurance of ample power being made available as needed for national defense without St. Lawrence power.

Steam Generating Units at ARGENTINE SUGAR PLANT

OF INGENIO SAN MARTIN DE TABACAL

A description of the recent extension to the boiler plant of the largest sugar refinery in South America, located in northern Argentine. The extension consists of two four-drum bent-tube boilers with economizers and air heaters and burning bagasse having a moisture content of 48 per cent. A fourteen-hour test showed an overall efficiency of 73.5 per cent.

By C. MELLOR, in collaboration with Ing. E. PATRON COSTAS

GENERATION of steam from low-grade fuels is a problem that has occupied many minds and considerable advances have been made during recent years, but there still remains a vast field for investigation regarding the types of furnaces best suited for burning wet vegetable fuels. Among these bagasse, the residual left by cane grinding mills in sugar factories, is one of the most important. It is interesting therefore, to review what is being done and the results attained at the cane sugar producing factory "Ingenio San Martín de Tabacal" which is situated in the Province of Salta in the extreme North of Argentine, close to the borders of Bolivia. This establishment is owned by Messrs. Patron Costas & Mosoteguy.

The surrounding country is very fertile and lies at an elevation of 1000 ft in the latitude 23 deg South, and nature favors it with ample rainfall. In size the factory ranks first of its kind in the whole of South America, it having a milling capacity of 5000 metric tons of sugar cane per day of 24 hr; and this year its sugar production has totaled 740,000 bags of 154 lb (70 kilos) during a campaign, or season, of 96 days. The whole of this sugar is refined and bagged in the Ingenio.

Besides the refining of sugar there is a distillery for alcohol, and this campaign has seen the distillation of 40,000 liters (10,526 U. S. gal) per day of 24 hr.

Prior to the installation of the two new boilers, which will here be described, steam was supplied by 18 standard longitudinal-drum B. & W. boilers, each of 4750 sq ft heating surface and suitable for operating at a steam pressure of 169 lb per sq in. Fourteen of these boilers are equipped with superheaters to deliver the steam at 250 C (482 F) final temperature, and are fitted with plate-type air heaters, induced- and forced-draft fans. The

Fig. 1—General view of Ingenio San Martín de Tabacal plant showing surrounding country

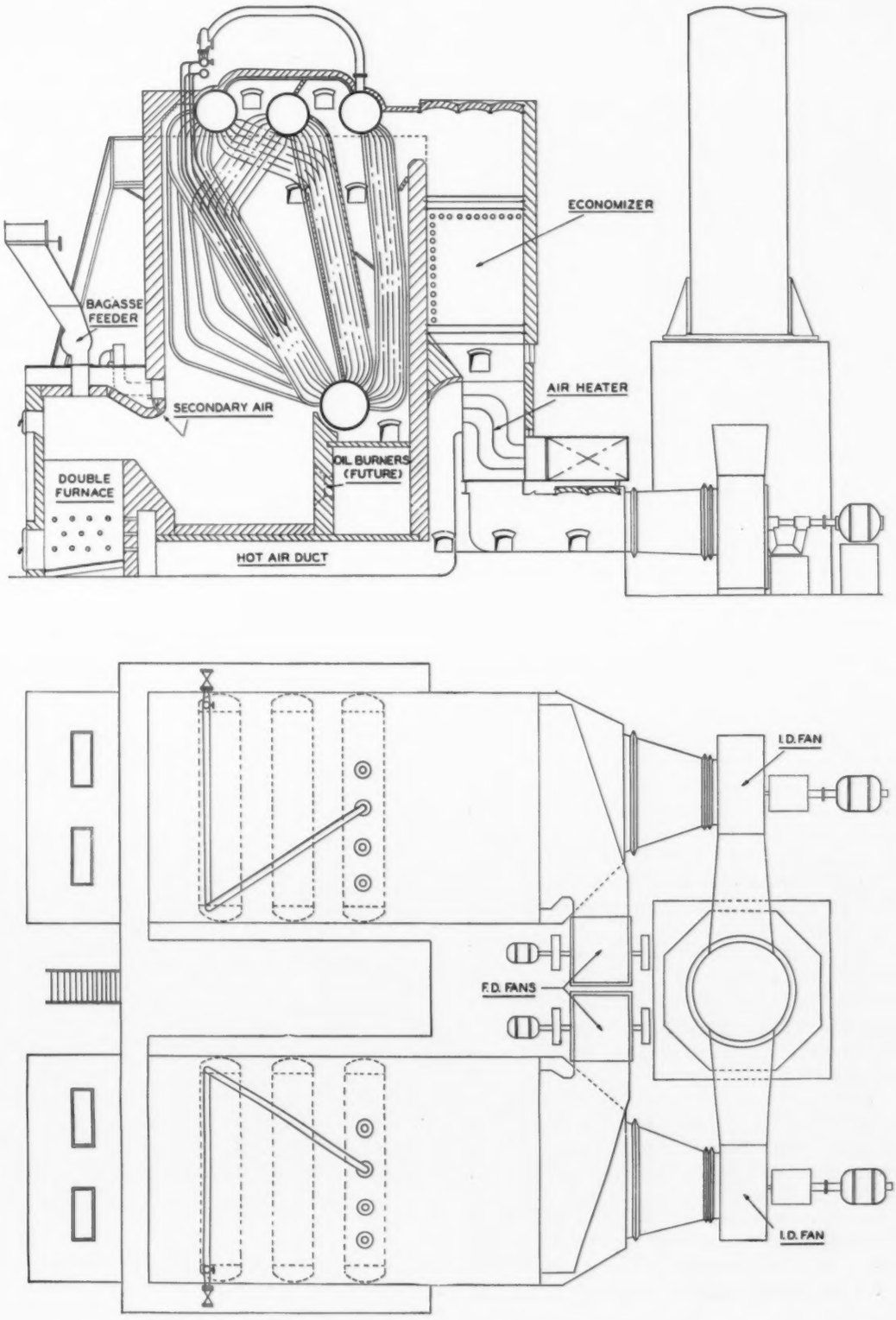


Fig. 2—Sectional view and plan of setting

steam from these boilers is first passed through turbines to generate power for operating the sugar mills, etc., and upon being exhausted from the turbines against a back pressure it is led to the factory for process work. The remaining four boilers have no heat-recovery equipment and supply saturated steam direct for process. All 18 boilers have step-grate bagasse furnaces, two furnaces per boiler, as well as auxiliary oil-burning equipment that is used to maintain the steam pressure

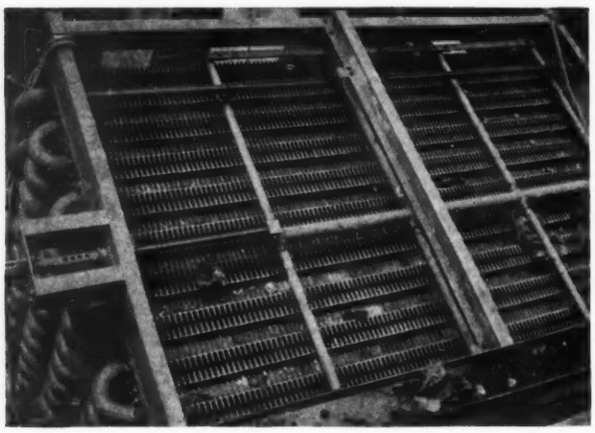


Fig. 3—Top view of economizer

during stoppages of the grinding mills, which cut off the supply of bagasse. Six of the boilers employ suspended arches to the ceiling of the furnaces, and the remainder have ordinary sprung arches.

Before the commencement of the 1939 season certain modifications were made in the factory, and during this campaign there was a considerable shortage of steam which made it necessary to burn some wood fuel over and above the bagasse made available from the mills.

When new boilers were decided upon it was considered advisable to concentrate on larger units and, in view of the past tendency to employ the straight-tube header-type boiler, this design at first was favored, but closer study brought out the superior merits of the bent-tube type with crossed circulation, and the final choice fell to two C. E. type VA four-drum, bent-tube boilers each of 12,774 sq ft heating surface.

In view of the comparatively high sucrose content of the cane grown in and around Tabacal, which results in a fiber residual of only 11.6 per cent, and the considerable quantities of steam used by the refinery and distillery, the owners decided to secure the maximum possible efficiency compatible with the economic outlay of capital. Accordingly, instructions for the design, supply and erection of the complete new steam generating plant were given to Mellor-Goodwin S. R. L. of Buenos Aires, agents for Combustion Engineering Co., Inc., of New York.

As is well known, the success or failure of any steam generating plant is largely dependent upon the furnace, and this is especially the case when a fuel containing 48 to 50 per cent moisture, such as bagasse, has to be burned.

Each of the two new boilers was supplied with twin furnaces which in general form resemble the Cook type. These, instead of being of the well-known horseshoe shape, are rectangular, amply supplied with expansion joints and intentionally rather deep. The furnaces are surrounded by air ducts which receive air at 266 to 284 F through ducts running under the floor of the combustion chamber and this air is finally introduced into the furnaces through a number of cast-iron nozzles suitably dimensioned and arranged in the walls.

Cleaning of the furnaces has been facilitated by fitting cast-iron floors that permit easy removal of ash and slag without accompanying injury to furnace brickwork, which is unavoidable when refractory furnace floors are utilized. Bagasse is brought from the mills by means of slat conveyors and fed through rotary feeders to the furnaces.

Secondary Air Produces Turbulence in the Combustion Chambers

Each pair of furnaces is equipped with Melte suspended arches with drop noses which provide an extended trajectory of the gases. At the point where the gases leave the furnaces and enter the combustion chamber, secondary air at high velocity is injected from a small fan which draws its air over the suspended arch (thus cooling the metallic parts of the latter) and delivers it into a longitudinal duct formed by the front wall supporting girders from whence it passes into nozzles in the nose of the suspended arch. In this way a high rate of turbulence is attained in the combustion chamber, which results in complete combustion before the gases enter the first bank of boiler tubes. In the design of boiler supplied, provision was made for cooling the upper part of the side walls of the combustion chamber by extending the outer rows of tubes so that they project well in front of the first row and thus are in front of the upper portion of the refractory side walls. This is shown in Fig. 3. Each boiler is provided with an Elesco intertube superheater.

Upon leaving the boiler, the gases pass to a Senior cast-iron economizer, having a heating surface of 10,000 sq ft, which raises the temperature of the feedwater to 347 F. This economizer is of very interesting design

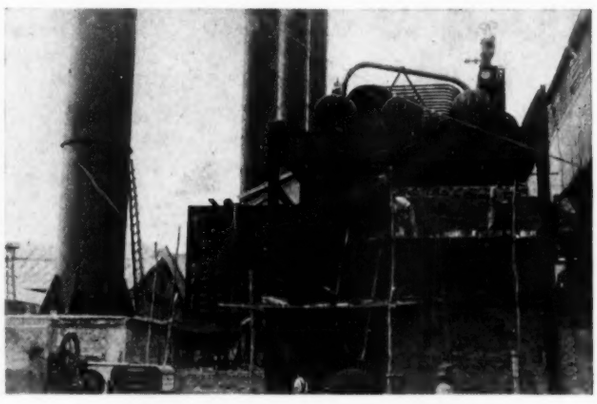


Fig. 4—Units in course of erection

and is shown in plan in Fig. 3. It has fins for extending the tube heating surface which, when the tubes composing the complete economizer are placed one alongside the other and one above the other, form vertical, straight and parallel passages through which the gases can be passed at high velocity with negligible draft loss. The design is particularly suited for gases proceeding from

the combustion of vegetable fuels because of the ease with which it may be maintained clean, and the high rate of heat transmission secured by high gas velocity for a given draft loss.

Upon leaving the economizers the gases pass to C. E. plate-type air heaters, which raise the temperature of the air for combustion to 230 F before entering the ducts in the combustion chamber floor. The gases leave the air heater at about 300 F and are delivered to the stack by the induced-draft fan. One 82-ft steel stack serves the two boilers.

Each boiler is provided with a Bailey steam meter which indicates and records the steam supplied to the main steam line connecting the boilers with the back-pressure turbines.

This plant has operated most successfully throughout the 1940 campaign which has recently terminated, and some further idea of its economic aspect and its good performance can be gleaned from the following 14-hr test figures.

TEST ON BOILER NO. 20, JULY 6 AND 7, 1940

Av. of 14-Hr Test	
Steam pressure, lb per sq in.	172
Steam temperature, F	435
Feedwater temperature to economizer, F	187
Feedwater temperature from economizer, F	342
Air temperature to air heater, F	79
Air temperature from air heater, F	234
Flue gas temperature at stack, F	301
Humidity of bagasse, per cent	48
Heat value of bagasse (dry), Btu per lb	8300
Heat value of bagasse as fired, Btu per lb	4320
Evaporation per lb of bagasse, lb	2.94
Heat Balance	
Loss due to moisture in fuel, per cent	12.7
Stack loss, per cent	6.3
Loss due to unburned fuel, per cent	3.0
Radiation and unaccounted for, per cent	4.5
Total losses, per cent	26.5
Efficiency based on high calorific value of fuel, per cent	73.5

DATA ON PRINCIPAL EQUIPMENT OF BOILER PLANT EXTENSION

Boilers:
Two, 4-drum bent-tube units, 12,774 sq ft each, designed for 180 lb pressure and equipped with Elesco superheaters—*Combustion Engineering Co., Inc.*

Economizers:
Two, cast-iron gilled tube, 10,000 sq ft each—*Senior Economizers Ltd., London*

Air Heaters:
Two, plate type, 8000 sq ft each—*Combustion Engineering Co., Inc.*

Induced-draft Fans:
Driven by 125-hp, 485-rpm G. E. motors—*Blackman Export Co., London*

Forced-draft Fans:
Driven by 50-hp, 960-rpm G. E. motors—*Clarage Fan Co*

Soot Blowers:
Furnished by *Diamond Power Specialty Corp.*

Engineering:
Done by *Mellor-Goodwin Soc. de Resp. Ltda., Buenos Aires*

Bituminous Coal Production

The National Coal Association reports a total bituminous coal production during 1940 of 450,000,000 tons which represents an increase of 14.4 per cent over the figure for 1939. During the week ending December 14, which may be taken as typical of the winter demand under present conditions, the output was 9,800,000 net tons which represented 81.7 per cent of the present mine capacity.

Last year was the biggest and best year for bituminous coal since 1930 and the outlook for 1941 is one of expanded production and increased markets.

Increased Power Capacity

According to the Edison Electric Institute, generating capacity added in stations contributing to the public supply of electricity in 1940 amounted to 1,790,000 kw. The net gain in capacity, after deducting for equipment retired from service or reduced in capacity rating, was 1,380,000 kw, thus bringing the total generating capacity at the end of the year to 40,330,000 kw.

Peak loads on the various utility systems averaged about 10 per cent over the figure for 1939, and the total installed generating capacity of the country was about 30 per cent in excess of the sum of the individual peaks.

The output of electricity, by private and public agencies contributing to the public supply, was 140,750,000,000 kwhr, compared with 126,666,317,000 kwhr for 1939. Of this total, fuels produced 94,500,000,000 kwhr, an increase of 13 per cent, and water power 46,250,000,000 kwhr, an increase of $7\frac{1}{2}$ per cent.

Generating capacity to be installed in 1941 was given as 3,412,000 kw and it was estimated that 2,302,000 kw additional would be added in 1942. Construction budgets of privately owned utilities for 1941 will exceed 1940 construction expenditures by approximately one hundred million dollars, the 1940 budget having been 580 million. This is exclusive of expenditures by public agencies for power purposes.

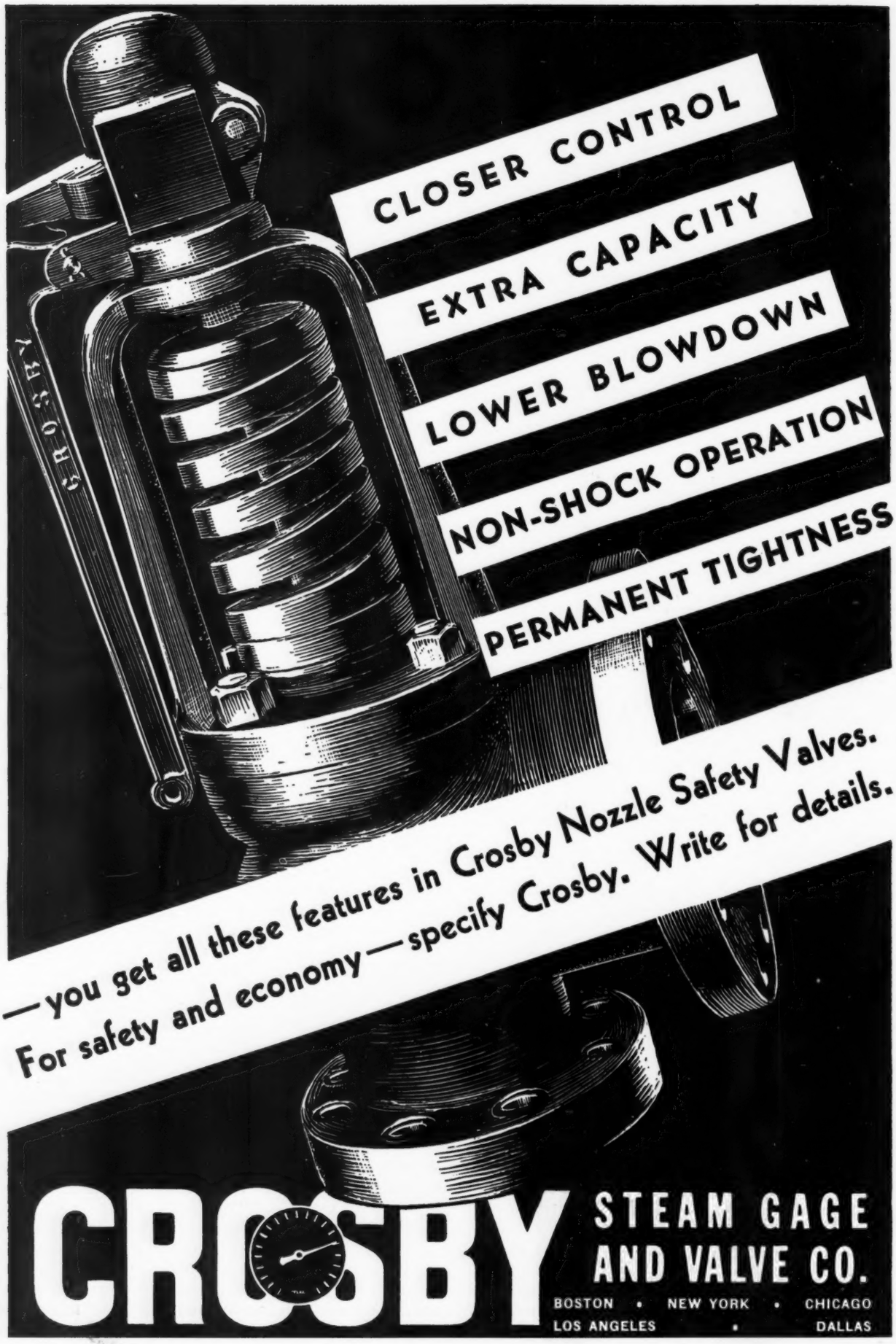
Thus it would appear that the utilities should be in a position to meet all probable power demands of the defense program as far as concerns the supply for public use.

Ash-Bearing Constituents vs. Pulverizing Power

A. C. Fieldner and W. E. Rice, in the Annual Report of Research and Technologic Work on Coal by the Bureau of Mines, state that "contrary to general belief the ash-bearing constituents are not always most resistant to crushing." Tests conducted to determine the energy consumed in pulverizing different coals, with particular reference to such constituents as vitrain, clarain, durain and fusain, for a range of minus 20 mesh to minus 50 mesh, gave the following results:

	Fusain	Vitrain	Clarain	Durain
Net horsepower-hours per ton of minus 150-mesh product	1.8	3.8	5.1	13.6
Ash, per cent	15.6	2.2	8.3	5.2

Durain, the hardest constituent, contains less ash than the clarain. Although comparison of the values for fusain with any of the others is even more startling, it has been recognized that fusain is the most easily crushed constituent, despite its relatively large percentage of ash. Tests of washed Alabama coal showed that the low specific gravity material and relatively low ash required 20 per cent more power for pulverization than the higher specific gravity and relatively higher ash material.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Waste-Heat Boilers

By

J. B. CRANE

Combustion Engineering Company, Inc.

A discussion of the boiler types adapted to the recovery of heat from exhaust or from waste gases incident to industrial processes. Certain fundamental differences between waste-heat and fuel-fired boilers are pointed out and typical calculations are included to illustrate the economics of waste-heat recovery.

THE temperature of gases from industrial furnaces ranges from 900 to 2000 F, according to the process involved. In many cases these gases are passed over brickwork which preheats the incoming combustion air, and they emerge at 1000 to 1200 F. Where they contain valuable materials that warrant recovery they are usually cooled for this purpose.

To use such waste gases for heat recovery it is necessary to employ higher velocities than usually obtain in ordinary boiler work. Although this involves increased draft loss and the use of induced-draft fans, the latter permit increased output and better draft regulation.

In boiler work the term "pounds of gas per square foot of free area per hour (mass flow)" is generally employed, as this is a constant quantity; whereas the use of velocity in feet per second would require considerable labor to figure the cubic contents of the gas in accordance with varying temperatures. In ordinary boiler calculations mass flows of 2000 to 3000 lb per sq ft of free area are common, but in waste-heat work the mass flow is stepped up to 6000 or 8000 lb.

In Fig. 1 is plotted draft loss versus mass flow (W/A), and the increase in exit gas temperature with increased mass flow for a typical waste-heat boiler of the return-tubular type in which the entering gases are taken as 1200 F.

Fig. 2 indicates the general relation between mass flow and draft loss, or fan power, as well as the effect of decreasing the heating surface swept by the gases, for a waste-heat boiler of the three-pass water-tube type with vertical baffling.

Typical Calculations

The weight of gas can be determined by knowing the weight of fuel, plus the weight of air for combustion, plus the weight of excess air, plus that of any moisture or gases released from the material being treated. For example, in a water-tube boiler, let

W = Weight of gas per hr (90,000 lb assumed)
S = Specific heat of gas (usually 0.26 to 0.27 in waste-heat work)
t_1 = Inlet temperature of gas to boiler (assume 1200 F)
t_2 = Outlet temperature of gas from boiler (assume 550 F)
T = Temperature drop ($t_1 - t_2$)
A = Free area around tubes, in square feet
W/A = Mass flow
$W \times S \times T$ = Btu available
Deduct 2 per cent for radiation loss
Assume 1000 Btu in one pound of steam
Then, Btu available = $90{,}000 \times (1200 - 550) \times 0.26 = 15{,}210{,}000$
$15{,}210{,}000 \div 1000 = 15{,}210$ lb of steam per hour, neglecting radiation
$15{,}210{,}000 \times 0.98 = 14{,}900$ lb of steam per hour, accounting for radiation

To illustrate the economic comparisons for this example with different mass flows, the following tabulation is offered:

Mass flow, W/A	2000	7000	10,000
Heating surface, sq ft	12,000	6600	4400
Output, lb of steam per hr	14,900	14,900	14,900
Steam to drive fan (turbine hp × 30)	60	555	1050
Net output of boiler, lb per hr	14,840	14,345	13,850

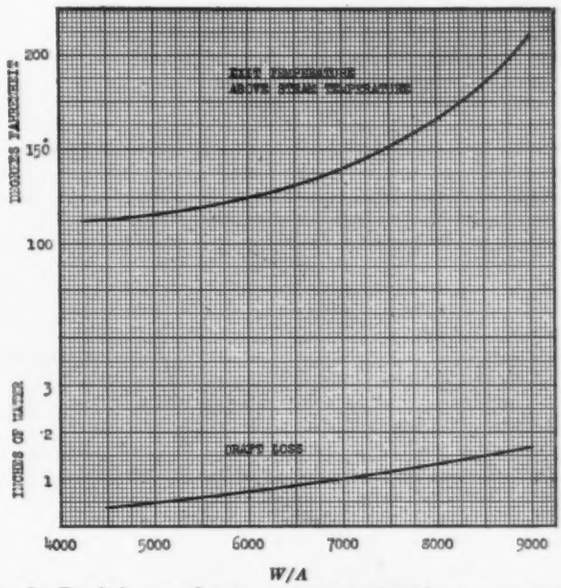

Fig. 1—Draft loss and exit gas temperature versus mass flow for 1200 F entering gas

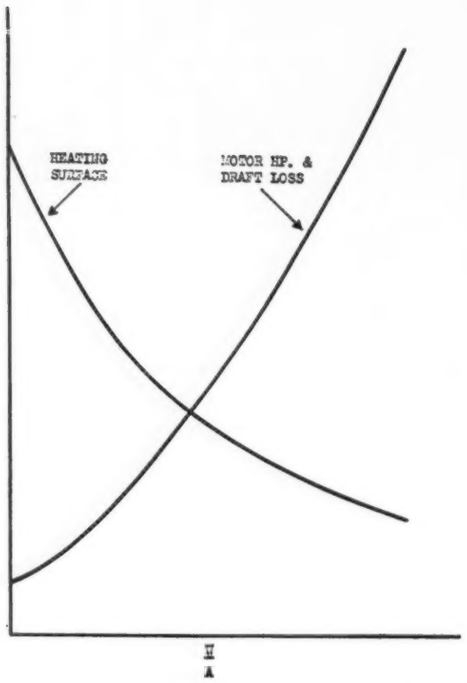

Fig. 2—General relation between heating surface, fan power and mass flow

Draft loss, in. of water	0.2	1.85	3.5
Turbine hp driving fan	2	18.5	35
Thousand pounds of steam per year of 8000 hr	118,720	115,760	110,800
Annual value of steam @ 40¢ per M lb	$47,488	$46,304	$44,320
Cost of installation*	$72,000	$47,500	$35,200
Maintenance, labor and supplies	$6000	$6000	$6000
Taxes, interest and depreciation @ 12%	$8640	$5700	$4224
Total yearly operating cost	$14,640	$11,700	$10,224
Annual savings, dollars	$32,848	$34,604	$34,096
Per cent on investment	45.6	73	96.8

Although the 4400-sq ft boiler with high mass velocity and high draft loss shows the greatest return on the investment, a mass flow of 10,000 lb per sq ft per hr would involve radical departures in design which might involve operating difficulties that would eventually offset the apparent gain. Therefore, the 6600-sq ft boiler with a mass flow of 7000 lb would probably be selected.

While one does not read very much in the technical press concerning waste-heat boilers, the number in service is large and one company alone has sold approximately a million square feet of heating surface for such service, which on a conservative estimate is saving over a million tons of coal per annum.

** The cost of a waste-heat boiler installation, including superheater and setting, has been assumed in this example as $6 per sq ft for a 12,000-sq ft boiler, $7.50 per sq ft for a 6600-sq ft boiler and $8 per sq ft for a 4400-sq ft boiler.*

Fire-Tube Boilers

Fire-tube, water-tube and forced-circulation boilers of various designs are employed for waste-heat service.

Advantages of the fire-tube type are:

1. No brickwork, and the shell is covered with insulation.
2. The boiler and connections are tight, which prevents air infiltration.
3. The gases pass straight through and thus give relatively low draft loss.
4. The superheater can be placed in front of the boiler, if the gas flow and temperature are steady.

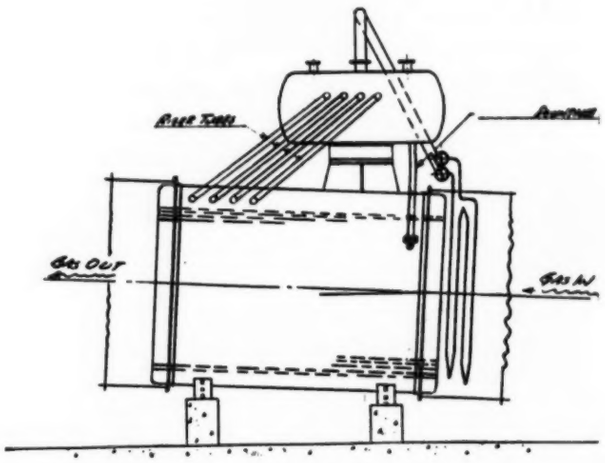

Fig. 4—By providing an external steam drum more heating surface can be installed in the shell

5. The boiler can be set vertically and thus take up small floor space.
6. Relatively low cost.

Offsetting these advantages are the following disadvantages:

1. Gases containing sticky materials are likely to form deposits on the head and tubes.
2. The pressure is limited to about 200 lb per sq in.
3. If there is wide variation in the flow or temperature of the gases, and the superheater is placed in front of the boiler, a varying steam temperature may result.

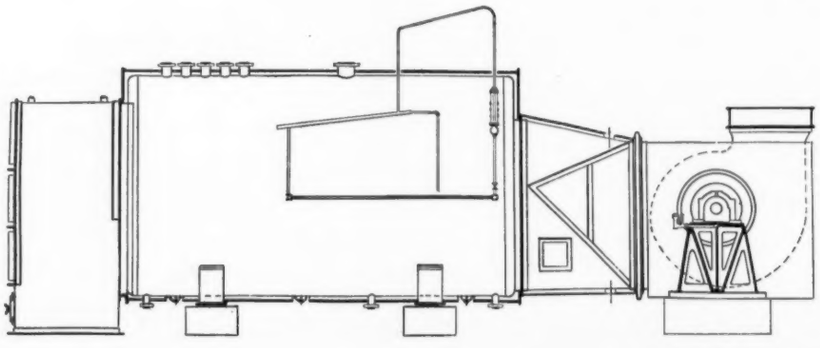

Fig. 3—Typical horizontal fire-tube waste-heat boiler installed in oil refinery

4. With abrasive materials in the gas, such as cement dust, high gas velocity will cut the tubes.

Many such boilers, operating in connection with open-hearth furnaces, are 106 in. in diameter and contain 6000 sq ft of heating surface. The tubes are generally 2 or $2^1/_2$ in. diameter, 18 to 24 ft long and are packed closely

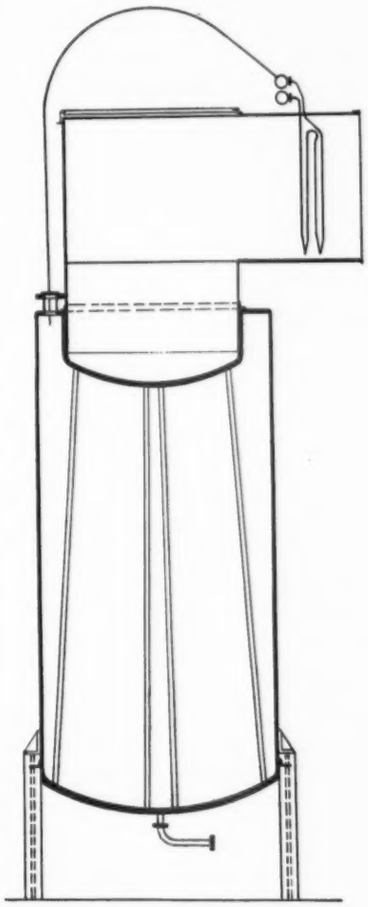

Fig. 5—Special design of vertical fire-tube boiler

in the shell. In one case 1343 2-in. tubes containing 12,742 sq ft of heating surface were used in a 135-in. diameter shell, 20 ft long. The illustrations show a variety of designs of fire-tube boilers as adapted to chemical furnaces, coke ovens, open-hearth furnaces, sodium furnaces, cracking stills and gas generators.

Fig. 3 represents a horizontal fire-tube boiler utilizing waste heat from an oil refinery. Sometimes such boilers are inclined about 15 deg from the horizontal with a view toward improving circulation. The gas enters at the low end and any solids entrained in the water will gravitate to this end where they can be blown down.

A waste-heat return-tubular boiler with an external drum is shown in Fig. 4. With this arrangement the steam space in the main shell can be less and thus permit the installation of more heating surface.

When waste-heat boilers of the return-tubular type were first placed in a vertical position, with gases admitted at the bottom, some trouble was encountered from overheating of the bottom head after solids had collected on the inside. On the other hand, when gases were admitted at the top similar trouble developed because steam was on the underside of the head. Therefore two designs were evolved to overcome this difficulty, both of which have been built and have given satisfactory service. One of these is shown in Fig. 5.

In this design the lower head is curved downward as is also the inner section of the upper head. Although the shell is cylindrical, the tubes are inclined slightly from the vertical in order to fit into the dished part of the upper head, from which extends the breeching containing the superheater. The gas flow is downward and the annular section formed by the upper part of the shell and the upper head forms the steam space, the inside of the upper head being covered with water.

Fig. 6 shows a vertically inclined fire-tube boiler having an external steam drum and designed to accomplish the same results. In both these cases accumulations of solids in the boiler water gravitate to a central point and are readily blown off.

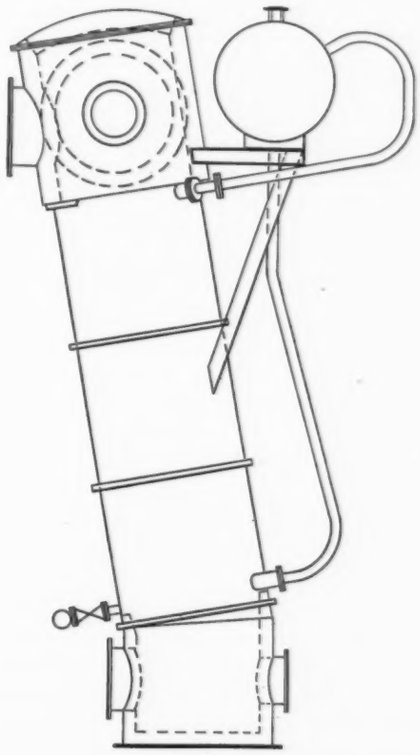

Fig. 6—Vertically inclined fire-tube boiler with external steam drum

The preferred arrangement is to have the gases enter at the top so that the hottest gas enters at the hottest part of the boiler.

In Fig. 7 is shown a waste-heat boiler installation applied to the recovery of heat through cooling hot material with air instead of using liquid for this purpose. This particular installation applies to coke ovens where the usual method has been to use water. The solid material to be cooled is deposited in a chamber which can be sealed against infiltration of air and a fan circulates air through the coke and then to the boiler surface. By using a closed circuit further combustion of the coke is prevented. This arrangement gives a larger percentage of metallurgical coke than the usual method; it generates

sufficient steam to provide a substantial return on the investment; and it cuts down maintenance on nearby structural steel and the nuisance caused by the discharge of wet gases from the liquid process.

Water-Tube Boilers

Water-tube boilers are used for pressures higher than 200 lb per sq in. and particularly where the waste gases contain sticky or abrasive material; also where capacities are involved that are greater than can be supplied by fire-tube boilers. They are used in connection with billet-heating furnaces, cement kilns, chemical-recovery units in paper mills, copper furnaces, incinerators, refuse furnaces and zinc furnaces.

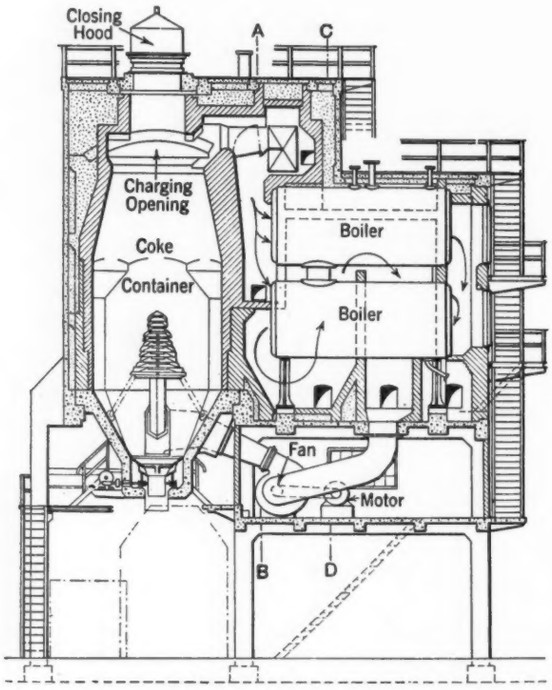

Fig. 7—Waste-heat boilers of the fire-tube type applied to coke oven process employing air for cooling the coke

The settings are usually constructed with 9 in. of refractory, a layer of insulation and, to provide the necessary tightness, an outside steel casing or a $4^1/_2$-in. course of insulating brick with a bitumastic covering. This expands and contracts with changes in temperature and gives a good base for paint. In this case it is necessary to tie together the inside and the outside refractory because the insulating brick has no strength and shrinks with use.

Early water-tube boilers for waste heat had straight tubes inclined 15 deg from the horizontal, and four passes were generally used. The box-header type was very popular for this purpose because it was easy to make the settings tight against infiltration of air. Economizers

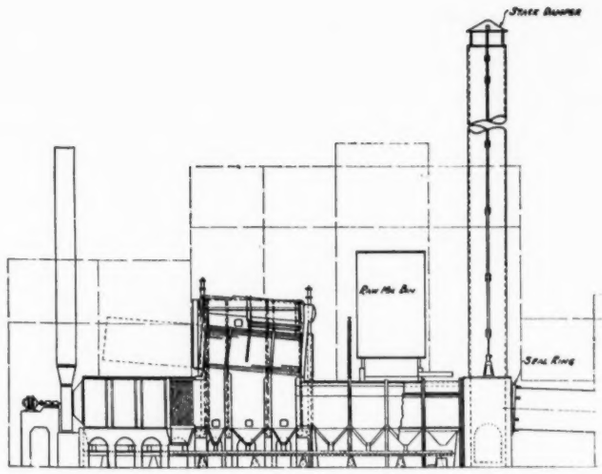

Fig. 8—Horizontal water-tube boiler utilizing waste heat from cement kiln

were frequently used in order to obtain the maximum amount of steam, and it was found that the relatively high draft loss through the boiler could be reduced by adopting two passes instead of four. In this case the exit temperature of the gases from the economizer increased only about 10 deg, whereas the decreased power on the induced-draft fan more than made up for the slight decrease in efficiency. Fig. 8 represents such an installation, utilizing the waste gases from a cement kiln.

However, it was often difficult to clean the slightly inclined tubes when the gas was dirty; hence the vertical boiler has now become the preferred design. The two-drum type is ideal because the rating is seldom above 150 per cent and no special drum internals are necessary to give clean, dry steam. Furthermore, it is easy to arrange the tubes to provide some heating surface in front of the superheater so that the gases strike these boiler

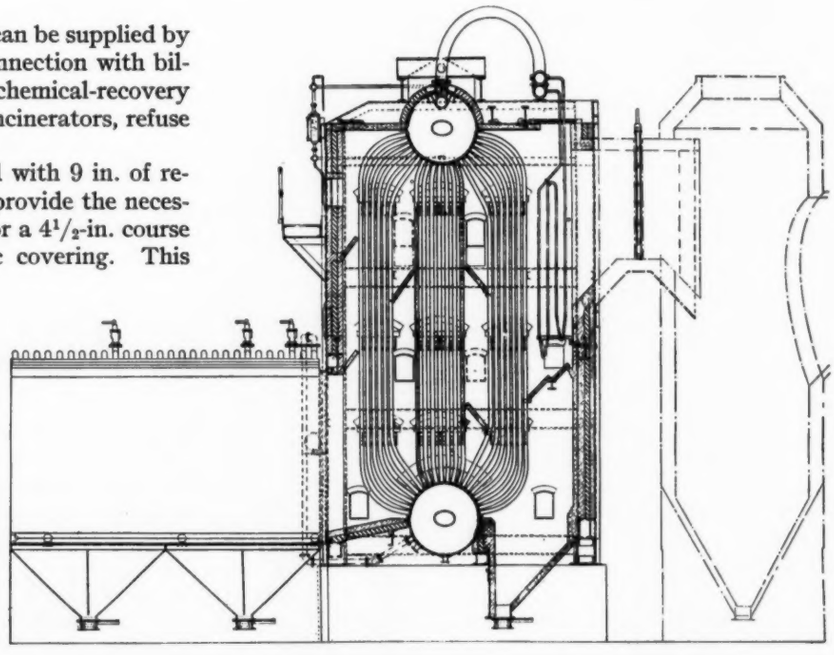

Fig. 9—Two-drum vertical water-tube boiler used in a cement mill

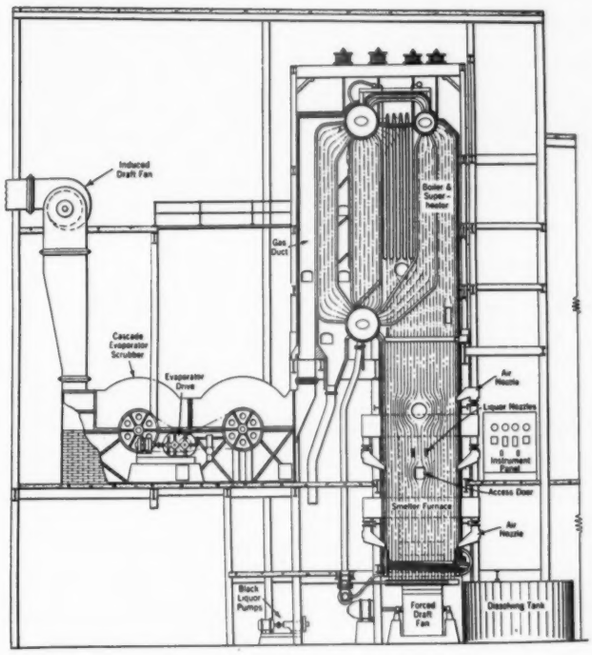

Fig. 10—Three-drum vertical water-tube boiler for chemical recovery in paper mill

tubes first and give a steadier steam temperature. Also, water walls can be readily applied if desired.

Fig. 9 shows a two-drum vertical boiler with $3^1/_4$-in. tubes, as applied on a cement mill. Sometimes both 3-in. and 2-in. tubes are employed. The tubes in the first bank can be spaced widely to keep a low gas velocity and prevent cutting of the tubes by abrasive materials in the gases. Frequently, an economizer is used. Such boilers are also used on steel mill furnaces, incinerators, billet-heating furnaces, copper and zinc furnaces.

Fig. 10 shows an arrangement of three-drum vertical boiler such as employed with chemical-recovery units in sulphate paper mills where the gases tend to stick to the first bank of boiler tubes. This first bank of tubes is widely spaced and lancing doors are so placed that this material can be readily removed during operation.

Forced-Circulation Waste-Heat Boilers

This type of boiler finds application to the exhaust gases of diesel and gas engines, to water-gas sets and to certain industrial processes, particularly where the gases are under pressure above atmospheric and are of such value that they must be conserved or recovered as by-products of the process. The number so employed runs into the hundreds. Such boilers are especially adapted to cases where the entering gas temperature is of the order of 500 to 700 F, because the small tubes ($1^1/_4$ in. and $1^1/_2$ in.) permit high rates of heat transfer with conservative draft loss. A separate steam drum may be provided or one drum may serve several such boilers as indicated in Fig. 11.

The cross-section of the elements comprising the boiler may be approximately circular, as shown in Fig. 12, or arranged as a rectangle as in Fig. 13. Up to a certain point the former is desirable as the circular arrangement offers the advantage of being better able to withstand gas under considerable pressure. However, due to the close spacing of the elements this arrangement is not advisable where the gases contain abrasive or sticky materials.

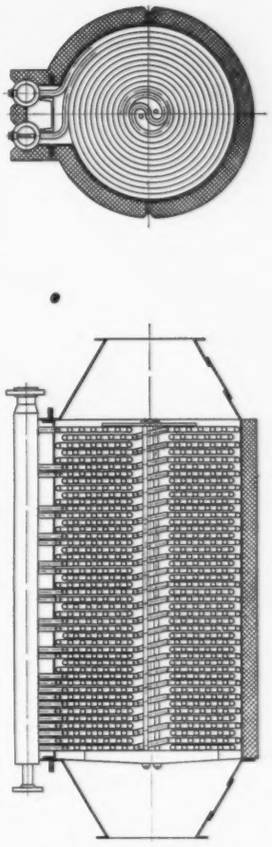

Fig. 12—Circular type of forced-circulation waste-heat boiler

An advantage in the forced-circulation boiler for waste-heat recovery which is lacking in the natural-circulation types is that it may be installed in any convenient location and the gases may pass through it in any direction desired, since the water is supplied to all the tubes by a pump in proportion to the heat being absorbed.

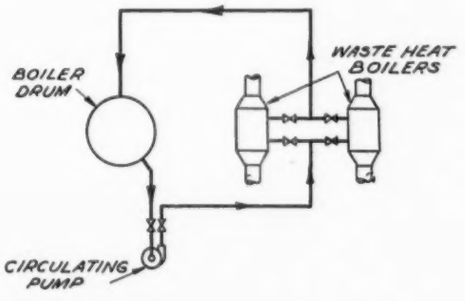

Fig. 11—Schematic arrangement of circulation for forced-circulation waste-heat boilers with separate drum

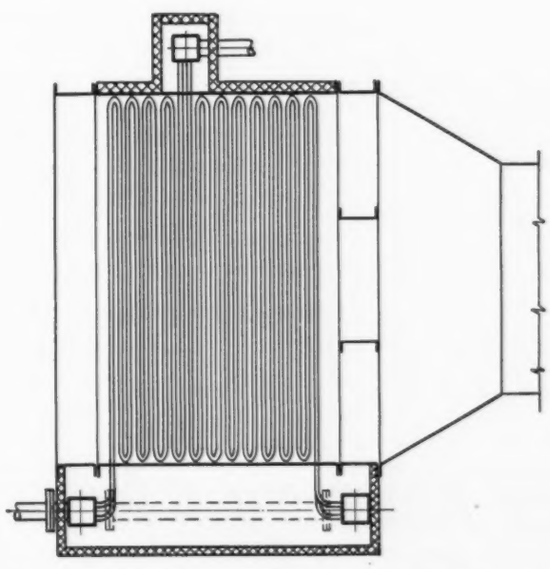

Fig. 13—Rectangular arrangement for forced-circulation waste-heat boiler

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Operation of Centrifugal Boiler-Feed Pumps*

By HANS GARTMANN

De Laval Steam Turbine Company

The installation of the feed pump at the proper elevation below the heater to obtain a positive suction head and thus avoid the formation of vapor, is discussed at length as is also the necessity for maintaining sufficient flow through the pump to prevent overheating.

MODERN centrifugal boiler-feed pumps have been called "the heart of the power plant" and failure of these pumps from any cause whatever is about as much of a calamity for a power plant as the failure of the human heart is for an individual. The water capacity of a modern boiler is great enough to supply steam to the prime mover for a period of only one or two minutes when operating at full load, and this fact illustrates the extreme importance and necessity of uninterrupted water supply to the boilers from the boiler-feed pumps.

Primarily it is the endeavor of the manufacturer to furnish his customer a boiler-feed pump of proper design, materials and workmanship to assure continuous trouble-free operation. However, the secondary considerations of proper installation and operation are just as important for satisfactory performance and it is these latter points that will be briefly considered here.

There are two vital factors essential to trouble-free operation.

1. The pump must have sufficient pressure on the suction at all times to prevent the water in the suction from flashing into steam.
2. There must be sufficient flow through the pump at all times to prevent overheating.

Suction Pressure

In the majority of modern installations the boiler-feed pump takes its supply from a feedwater heater wherein exists a temperature corresponding to the pressure as found in the steam tables for saturated steam. (See Fig. 1.) If the pump were installed at the same level as the heater (assuming the water temperature to approximate 212 F), this would indicate that it would be working at a suction pressure equivalent to that of a pump handling cold water at about 75 F temperature and having 33 ft lift. It is therefore necessary to install the boiler-feed pump at an elevation sufficiently below the heater so as to obtain a reasonable net positive suction head and thus to prevent vaporization of the water in the suction impeller.

By experience, it has been found that a positive net head of 20 ft on the suction for 212-F water results in satisfactory operation for speeds as high as 3500 rpm and capacities up to about 1000 gpm. This net positive suction head is defined as the absolute pressure measured by gage at the pump suction flange corrected to the center-line of the pump *minus* the vapor pressure corresponding to the temperature. It consists, in effect, of the static elevation difference between heater water level and center-line of pump *minus* the friction loss in the suction line and *minus* the velocity head of the water

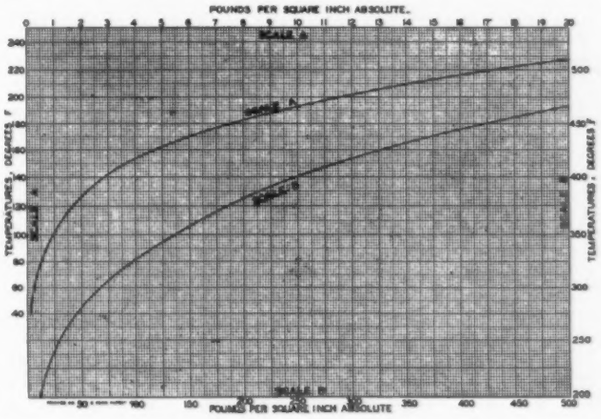

Fig. 1—Temperatures of saturated water vapor at different absolute pressures

in the suction nozzle. The necessary net positive head is to a certain extent influenced by the speed and the capacity of the pump; that is, by the specific speed of the unit, as high inlet tip speeds naturally require a greater margin of safety.

One approach to this problem has been made by our Chief Engineer by using the latest Hydraulic Institute Specific Speed Chart as a basis. It should be feasible to select the proper values of net positive suction head from this chart by simply adding 33 ft to the suction pressures obtained from the chart for different specific speeds. The full line curves in Fig. 2 show the values thus obtained at different capacities for four speeds. The 3500-, 2900- and 2500-rpm curves are calculated for a total dynamic head of 400 ft for the suction impeller and the 1750-rpm curve for a head of 300 ft. For low capacities the values of net positive suction head have been arbitrarily increased above calculated amounts. This seemed proper because the shaft size and the eye diameter of the impeller are relatively larger in multi-

* One of the winning papers in the recent "First Annual Engineering Essay Contest" of the Hydraulic Institute, through the courtesy of which COMBUSTION is enabled to print this paper.

stage pumps of moderate and low capacities than in single-stage pumps. For 1750 rpm, 12 ft net positive suction head is recommended as the minimum. For ideal operating conditions and water temperatures not exceeding 250 F, satisfactory performance may be expected with suction pressures as indicated by these curves. The 3500-rpm curve is marked as being correct for pressures up to 1000 lb per sq in. For reasons brought out later in this paper, pumps designed for greater discharge pressures require a still larger margin of safety

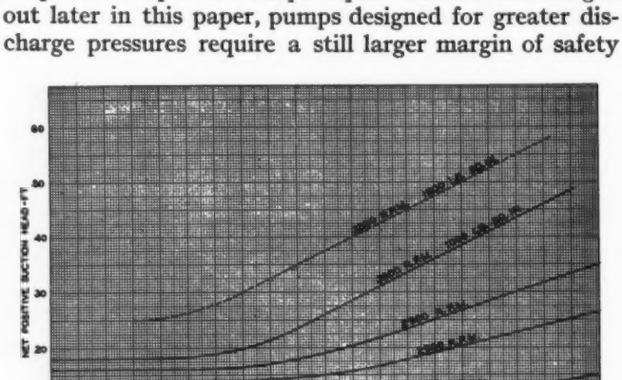

Fig. 2—Proposed curves of net positive suction head

and the dotted line marked 3500 rpm, 1600 lb shows the net positive suction head for pumps having 1600 lb per sq in. discharge pressure or above, as submitted by two other pump manufacturers.

The necessary net positive suction head is further influenced by the water temperatures, and in order to extend the experience factor mentioned above to other water temperatures the term "temperature margin" has been introduced by various writers. The temperature margin is defined as the difference between the temperature corresponding to the actual suction pressures as found from the steam table for saturated steam minus the actual inlet temperature of the water coming to the pump. It was previously stated that satisfactory operation is obtained with 20 ft excess head on the suction for boiler-feed pumps handling 212-F water. In this example, the temperature margin amounts to 24 deg F, which means that the temperature of the liquid coming to the pump could theoretically be increased 24 deg F before flashing would occur. Now for a pump handling 350-F water and having the same net positive suction head of 20 ft, the temperature margin is only about 4 deg F, or, expressed another way, it would require a net positive suction head of 123 ft to obtain the same temperature margin for 350-F water, as with 20 ft for 212-F water.

Experience indicates, however, that for the higher temperatures such a large margin is not required and it is suggested that for temperatures above 250 F a temperature margin of at least 5 deg F be selected in cases where the net positive suction head selected from the curves in Fig. 2 would give less than this amount of margin.

It will be evident from the foregoing that it is always advantageous to install a boiler-feed pump with as much positive net head on the suction as the station layout will permit. This is particularly true of pumps taking their suction from direct-contact heaters which are subject to sudden fluctuation in pressures, with resultant time lag between pressure reductions in the heater and corresponding temperature reduction at the suction nozzle. In order to avoid the formation of vapor in the suction of the pump and causing momentary loss of suction under these conditions, an additional pressure margin must be provided. Where this cannot be done, measures should be taken by the operator which will positively prevent rapid fluctuations in the heater pressure, particularly for high-temperature pumps where the temperature margin is necessarily small.

If these precautions are not taken and the pump is allowed to operate with too low a suction pressure, vibration, rapid wear of the wearing rings and even seizing of the pump will result. As the flow through the pump will be reduced or even stopped during these incidents, the resultant phenomena will be covered more fully in the next paragraph.

Necessity for Maintaining Sufficient Flow Through Pump

In any centrifugal pump, the difference between the work or horsepower put into the pump and the useful work or water horsepower performed by the pump is converted into heat. A very small amount of this heat is dissipated by radiation, but most of it will be absorbed by the water passing through the pump and for all practical purposes we may safely assume that all of this horsepower difference will show up as heat in the pump discharge.

To illustrate this, the bhp curve of a pump rated at 350 gpm, 600 lb pressure and also the corresponding water horsepower curve are shown in Fig. 3. The difference between these curves at any one capacity represents the horsepower that will be absorbed by the water in heat; and by multiplying these values by 42.4 we will get the Btu per min put into the pump. Dividing the values

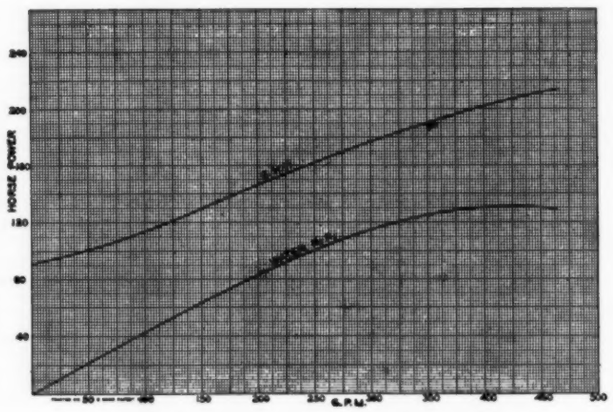

Fig. 3—Boiler-feed pump horsepower curves

thus found by the pounds per minute passing through the pump will give the temperature rise for each capacity. Fig. 4 shows the resultant values plotted in curve form.

Temperature readings were also taken during an actual performance test on the same pump and the results of this test are also shown in Fig. 4. The test curve practically coincides with the values arrived at by calculation and the comparison of the two curves shows that the influence of radiation on the actual water temperature is for all practical purposes negligible.

It will be evident from these curves that at normal operating conditions the temperature rise is very small

and should not cause any operating difficulties. However, at very much reduced capacity or at zero discharge the temperature of all the water in the pump will be increased as shown in Fig. 4; and this change will take place in about one minute, depending on the physical dimensions of the pump. The rapid and extreme temperature change may cause the inner rotating parts to heat so much more rapidly than the heavier encircling parts that severe rubbing may occur.

Most boiler-feed pumps, especially those for higher pressure, have single-suction wheels all facing in the same

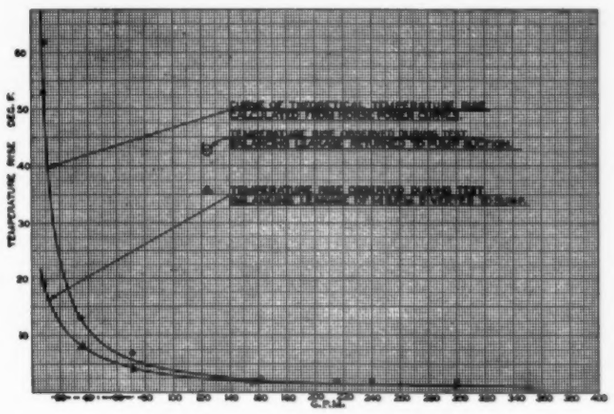

Fig. 4—Curves of temperature rise

direction and employ a leak-off balancing arrangement to compensate for the hydraulic thrust inherent in this design. If this balancing leak-off volume is returned to the suction of the pump at extremely low rates of delivery, the whole pump will not only heat up rapidly but flashing will occur almost immediately in the suction impeller. Then, the lack of liquid for lubricating and cooling the wearing-ring surfaces under these conditions, combined with the rapid temperature increase, will most likely cause the pump to seize.

It is for this reason that our company has for several years provided specially designed three-way valves in the balance pipes of all boiler-feed pumps and, in every case, recommends that the three-way valve be piped to the heater in the feed system ahead of the pump where the excess heat is automatically removed by evaporation.

Fig. 4 shows another curve of the temperature rise of the pump as determined by actual test with the balancing leakage diverted and shows the resultant reduction of the temperature rise in the pump for very small capacities. The balancing leakage amounted to 14 gpm or approximately 4 per cent of the rated capacity for this particular unit.

With the balancing system hooked up to the heater, the balance pipe on the pump still serves a useful purpose in that it affords passage to the suction system for the balancing leakage in the event that the three-way valve is inadvertently closed to the heater. The valve, it should be noted, is constructed as shown diagrammatically in Fig. 5, so that regardless of its position it cannot interfere with the free flow of water through the balancing elements.

No other valve whatsoever should be placed between the pump and the heater as an accidental closing off of this line would immediately destroy the pump balance and would cause the balancing parts to seize. When it becomes necessary to disconnect the heater from the pump for the purpose of opening the pump, the three-way valve should be used for this purpose.

As can be seen from Fig. 4, even with the balancing leakage diverted to the heater, if the pump should be called upon to operate close to no delivery the temperature rise of the water in the pump may still exceed the temperature margin provided for on the suction of the pump. The simplest remedy for preventing damage to the pump under these conditions is the installation of a small line from the pump discharge to the heater through a stop valve and an orifice of such size that it will pass about 10 per cent of the rated capacity of the pump at the rated discharge pressure. This bypass connection should be opened wide whenever it becomes necessary to operate at very low rates of delivery or at shutoff pressure. In addition to having the bypass open when operating at reduced capacities for a considerable time, it is desirable to open the bypass when putting a pump on the line or taking it off, or when changing over from one feed pump to another.

In the majority of installations, the bypass is manually controlled by the operator and is opened when the demand is likely to drop below a safe minimum. There is, however, an automatic valve on the market sold in connection with a feedwater meter that automatically opens the bypass when the demand drops to a predetermined figure.

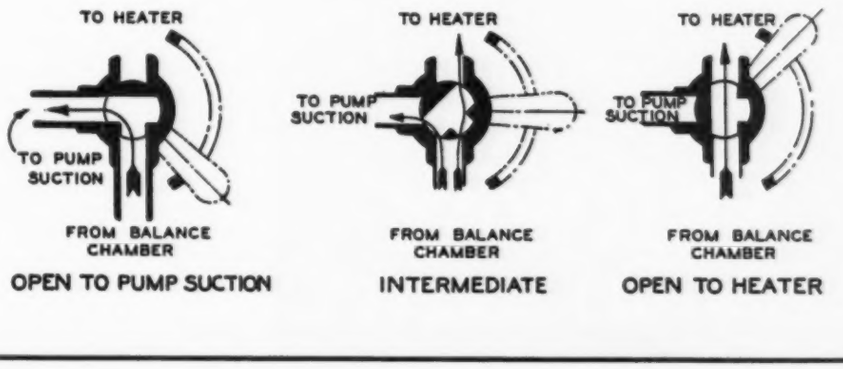

Fig. 5—Arrangement of three-way valve in balancing piping for boiler-feed pump

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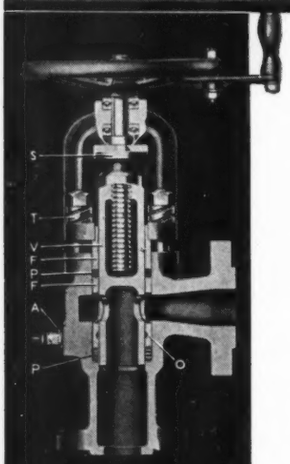

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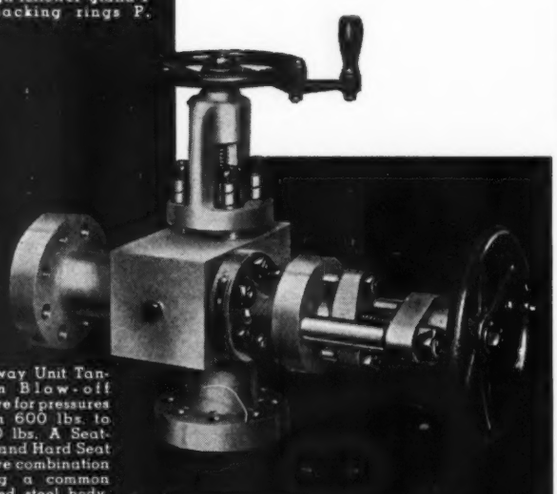


Yarway Unit Tandem Blow-off Valve for pressures from 600 lbs. to 1500 lbs. A Seatless and Hard Seat Valve combination using a common forged steel body.

YARWAY

BLOW-OFF VALVES

Another way of controlling the bypass automatically, suitable for motor-driven pumps, is to actuate the control valve from the input to the driving motor. As can be seen from Fig. 3 the bhp curve decreases continuously with decreasing capacity, and when the kilowatt input reaches the point on the curve corresponding to the minimum safe capacity, the bypass valve is opened electrically through suitable relays. This arrangement has been used successfully on one of our larger installations.

The auxiliary piping system can be simplified where necessary by piping both the balancing and the bypass connections to the heater through a common line as shown diagrammatically in Fig. 6. It should be noted in connection with this plan that the common line to the heater must be of sufficient size to pass about 15 per cent of the rated capacity of the pump and that there should be no valve of any kind between the junction of the balancing and leak-off connections and the heater.

The fact that this discussion has centered mainly on the type of pump which is equipped with a balancing

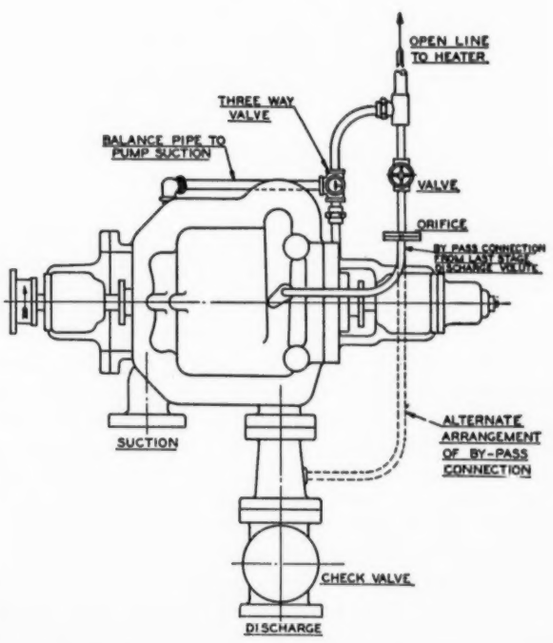


Fig. 6—Balancing and recirculating connections

device is not to be interpreted as meaning that the same precautions are unnecessary in the case of a pump without the balancing device, such as the so-called back-to-back pump. Obviously, the suction pressure requirement is not affected by the pump design, and necessity for providing some means for insuring sufficient flow through the pump at low rates of delivery to prevent overheating applies to all types of boiler-feed pumps.

Actually, on a pump having a balancing device which is properly piped to the heater, the balancing leakage will act as a safeguard in reducing dangerous temperature increases should the pump load drop suddenly to a very small amount before the operator has time to open the bypass valve.

BOILER EMBRITTLEMENT PROTECTION

By CYRUS W. RICE

Water Chemist and Engineer, Pittsburgh, Pa.

In reviewing present knowledge as to embrittlement protection and prevailing practices the author offers explanations for certain apparently conflicting experiences and shows how, under different circumstances, some salts may either accelerate or prevent embrittlement.

AS SOME few boiler operators have been opposed to the use of treatments for the prevention of embrittlement and results of research have confused their value, analysis of this situation is in order.

A Sub-Code Committee of the American Society of Mechanical Engineers, of which the writer has been a member for nearly twenty years, has given preference to the analysis of such problems with facts obtained through everyday operating practices. A survey completed recently of boilers built to operate in excess of 400 lb pressure was made on this basis and evidence supplied by the operators and the conclusions finally reached by the Committee fully justified the practical means employed in this investigation.

Facts obtained in this way and from boiler manufacturers, and insurance companies, as well as through research efforts, have proven very definitely that one of the primary influences causing embrittlement is the leakage of caustic soda solutions into the underwater seams and their evaporation here to concentrations approximating 1200 times that carried in the average blowdown water. Such high densities can be reached better under slow evaporations and where there is little or none of the diluting influence of leakage through the seams to atmospheric waste. The tight or nearly tight outside-caulked underwater seam fits this condition well. Furthermore, the wide, inter-connecting spaces which run the full length of longitudinal seams in this kind of joint allow for the widest distribution of these caustic influences.

Some authorities are of the opinion that this caustic influence is still further spread through such joints by circulations set up by thermostatic influences. Again, while internal caulking of riveted construction may prevent leakage of caustic soda solutions into the seams, it does not eliminate the hazard of the outside-caulked joint, should any part of the inside caulking open up. With an internally-caulked boiler, in which such leakage occurs, repairs from the inside are difficult or almost impossible; hence the seam must be caulked externally to make it tight; all of which invites trouble. This fault and such repair practice have not been uncommon.

It is the writer's opinion that, in most cases with tight, externally-caulked jobs, where caustic waters are in use and the inside joints are not tight, the real damage takes place within the seams before its presence is manifested through visible leakage. With such uncertainties it is important to obtain definite knowledge of the embrittling characteristics of the feedwater, rather than to continue in the blind manner that has led to many failures in the past. Obtaining facts of this kind is not expensive and may prove the means of avoiding serious future consequences. This statement only applies to boilers with underwater seams that are externally caulked or both externally and internally caulked. It is under such circumstances that employment of embrittlement protection practices should not be discouraged because of some disagreements as to the value of corrective measures.

A review of literature on this subject indicates, with few exceptions, that research chemists and most engineers are in close agreement as to the embrittling influences of highly concentrated caustic soda solutions when supplied under boiler-water conditions and in contact with highly stressed boiler metal.

Early Indications of Embrittlement

Records show that a succession of failures of this kind followed the use of natural waters containing soda around 1915. Earlier attention to these was directed by their unusual number and the fact that the well waters in use, with practically no exceptions, contained high sodium bicarbonates and low sulphates. Other records then showed the predominating cracks in these failures to be intercrystalline and to occur within the underwater seams. Similar failures were reported at about the same time to caustic-soda evaporators and to boilers employed in connection with these processes.

Facts of this kind, together with the confirming work of Parr and Straub in the early days, were responsible in 1926 for Paragraph CA-5 of the A.S.M.E. Boiler Code. This only included sulphates as the inhibitor, as the practical information then available and upon which the Committee's conclusions were based, covered no other remedy having similar properties. Furthermore, the advice extended by the Committee was only a suggestion, with no restrictions as to amendments, should

additional information render it necessary to make other recommendations.

The improved results that were reported following the use of sulphates and improved water conditions in general in the cases since 1926, confirm rather than deny the embrittlement protection properties of this treatment.

The most outstanding opponents of the sulphate ratio as prescribed in Paragraph CA-5 of the Boiler Code have been the railroads. A possible explanation for this opposition is that the constant sharp jolting of locomotive boilers in service may have destroyed the embrittlement-protection properties of the sulphates. This is logical because, according to some early opinions, it was thought that the sulphates formed compact deposits of such a nature as to seal the underwater seams against the leakage into them of caustic soda solutions. Realizing the brittle nature of salt formations in general, it is not difficult to reach conclusions as to the results of repeated sharp jolts on seams where sulphates are either employed or are contained in the natural water.

We are better informed as to the real causes of burned-out tubes because the composition of the deposits responsible have been determined, and compiled records of these analyses are available for study. Facts obtained in this way have clearly designated the deposits that are most troublesome in causing boiler and superheater tube failures. It is known definitely that silica is the most effective of all such deposits in preventing water from cooling the heating surfaces and that it requires less than $^1/_{100}$ in. of such formations to burn out boiler tubes. Hence, there is every reason to believe that this property of silica must also be highly effective in sealing the underwater seams against caustic leakages. This probably accounts for the absence of failures in some cases of long standing where every known influence existed in the most aggravated forms to cause embrittlement.

Cause of Tube Failures in Water-Starved Locations

Deposits of the more soluble sodium-chloride and sodium-sulphate salts over failed sections of superheater tubes show how these salts prevent the cooling action of the steam from protecting the metal. Analyses of boiler-tube deposits show these same salts to be the cause of boiler-tube failures in water-starved sections. It would appear logical to assume that these salts on reaching the solid phase within the underwater joints would be equally as effective in preventing caustic soda solutions from entering these joints and causing embrittlement. It is logical to conclude further that, whereas it is necessary to concentrate caustic-soda solutions of better than 1200 times to cause embrittlement, that the sodium-chloride and sulphate salts, usually associated more or less with the caustics, would reach this solid phase first. Caustic soda is much more soluble at boiler temperatures than the neutral salts just mentioned and would naturally be excluded from the joints where enough of the more insoluble salts are present to seal its flow and prevent further concentration to the densities which cause embrittlement. There is also plenty of field evidence to prove the value of silicates as sealing agents for excluding caustics from the underwater seams.

We, therefore, can have depositions of both insoluble materials and soluble salts prove destructive; while on the other hand, these same deposits are beneficial in preventing embrittlement. This would appear to explain why silica both accelerates and prevents the embrittlement effects of caustic soda and why sulphates may or may not protect boilers against this influence.

Although railroads have found sulphates of no value as embrittlement inhibitors, they have, on the other hand, been very successful with organic compounds in effecting decided reductions in repairs to locomotive boilers, due to embrittlement cracks. The writer believes that these different results in locomotive boiler operations definitely indicate the existence of two means for protection against embrittlement—one physical, as discussed above, and the second, chemical.

Comparative Costs of Protection with Sodium Sulphate and with Lignin

Again, because of the thoroughness with which Professor Straub and Doctor Schroeder both carried out their investigations on embrittlement, it appears much as though the equipments in use by each were tuned for different approaches to the solution of the problem. In any event, if the chemical correction of the embrittlement problem finds practical support, it should lead to a wider and more certain application in this field. One thing in its favor is its lower cost. The extent of this is best indicated in a case on trial now for about two years where 10 lb of lignin, costing about 45 cents, have been used regularly. Based on Paragraph CA-5 of the Boiler Code, it requires 150 lb of anhydrous sodium sulphate at a cost of $6.50 for the same purpose. These figures are conservative and show that the sulphates here would be nearly fifteen times the cost of lignin. A suggestion in this matter that would possibly bring this application of lignin or similar organic compounds into more common use would be to make a survey of all boiler classes not now excluded in the recent recommendations of the Boiler Code Committee. The questionnaire for this purpose should inquire specifically into the use of all organic materials, together with other pertinent information.

Other instances that have created doubt as to the necessity for employing embrittlement protection practices are the large number of stationary steam engineers who have gone along for many years and not concerned themselves about treatments of this kind. Some of these cases, with which the writer is familiar, would be considered most flagrant violations, according to the best advice on the subject. I refer, in particular, to a number of scattered old outside-caulked riveted boilers where the free soda concentrations ranged between 300 and 800 grains, with an abundance of silica and practically no sulphates, for fifteen years, without a sign of trouble from embrittlement. A case called to my attention recently showed the use of an 18-grain sodium bicarbonate well water, carrying 1.75 grains of silica, in use many years on old return-tubular boilers without incurring embrittlement. With the positive known embrittling properties of caustics alone or caustic and silica combinations in such operations, there must certainly be some reasons other than workmanship as to why boilers, under these conditions, did not fail.

This use of high caustic waters is not uncommon, but in view of present information, it would be trespassing

on good judgment to use such examples as excuses for voiding the valuable information that has been assembled for the protection of boilers against embrittlement.

With boilers built to stay tight against leakage, the necessity for embrittlement protection practices does not exist. That boiler manufacturers have successfully met this requirement is clearly evident in a recent survey of boiler installations built to operate at and above 400 lb pressure. Here, with a total of 452 boiler plants, including several hundred high-pressure boilers of this kind[1] two plant failures were reported and these, according to information from the boiler insurance companies, were due to faulty construction. In other words, 100 per cent would have been free from embrittlement had these faults not existed.

Boilers in this survey were built from 1926 to date and if time is a factor for developing sound judgment in the construction practices the new boilers of today should certainly be the very "tops" against leakage. Again, regardless of how urgently one may preach "necessity," the fact remains that embrittlement protection treatments often prove to be poor combinations, having tendencies, more or less, to cause steam contaminations with their associated troubles, all of which has developed some objection to the use of such materials.

In the final summary of this subject, the "fly in the ointment," so to speak, is the old type of construction or, in other words, the boilers that were built in accordance to the older specifications and which permit of the leakage and concentrations discussed. The most sensible solution to the problem is certainly the elimination of the externally-caulked and combination internally- and externally-caulked boilers. Where this is not possible, the next best procedure is to determine the embrittlement properties of the water in use and make the necessary corrections if they prove objectionable.

[1] That practically all high-pressure boilers now have welded drums is probably a large factor in this record.—EDITOR

Industrial Machinery That Passes with Sale of Premises

By LESLIE CHILDS

The seller of industrial machinery or equipment, that becomes firmly attached to the premises but which has not been fully paid for, may find himself divested of title or equity in favor of a buyer of the premises, if the latter has purchased without notice of the equipment seller's interest. This is strikingly illustrated in the following case:

Here the plaintiff, a company engaged in the sale of industrial machinery, sold certain equipment to the lessee of a mill, the purchase price to be paid in installments. The lessee's contract with the owner of the premises provided that he, the lessee, should have the right to remove this newly purchased machinery upon termination of the lease. However, before the equipment had been fully paid for, the lessee decided to give up operation of the mill and terminated the lease. At this time he had the unquestioned right to remove the machinery in question, but failed to do so.

Thereafter, the owner of the premises sold the property to another company, along with other property. The purchaser had no notice that any of the machinery therein did not pass with the sale, and it was clearly necessary to the operation of the mill.

At this time over a third of the purchase price of this particular machinery remained unpaid, and the plaintiff, the original seller of the equipment, took an assignment of it from the former lessee of the premises and claimed right to possession thereunder. However, the buyer of the mill property refused to give possession, claiming that the machinery had passed to him, free of all claims, by virtue of his purchase of the mill premises. Thereupon the plaintiff brought action to recover the machinery and received judgment in the lower court.

The case was appealed and the higher court reversed the ruling of the lower court, citing the general rule as stated in the decision in another case to the effect that, "When machinery adapted to the purpose of a manufacturing plant is installed therein and connected with the building by wires or belts, such machinery becomes a part of the freehold, and the land, buildings and machinery so attached constitute an entity and pass by deed, mortgage, or other conveyance of the land."

Following this citation the higher court stated that, from all physical appearences, the machinery was a part of the plant and, in the absence of any notice on the part of the seller of the premises, title passed to the purchaser by virtue of the deed of conveyance. It held further that it seemed beyond controversy that the buyer of the mill premises took good title to the mill, free and clear of any rights on the part of the former lessee and that the judgment rendered by the lower court in favor of the plaintiff was without justification or support in either fact or law.

Of course, the point here raised is one of many angles, with each case necessarily being decided upon its facts and circumstances, and perhaps some pertinent statute of the state in which the action arises. Therefore, the subject cannot be covered by any hard and fast rule that would apply to all cases.

However, this does not detract from the value of the case as an example to emphasize the importance of care in respect to credit security when industrial machinery and equipment, such as is to be firmly attached to the premises, is being sold on the installment plan. In such cases the seller may well see to it that the account, or his claim upon the equipment, is made secure against its loss by sale or mortgage of the premises by the purchaser or the owner.

New Mercury Boiler

Reporting on developments during 1940, the General Electric Company states that a mercury boiler having a single 54-in. drum replaced the seven-drum boiler installed several years ago at the Kearny Station of the Public Service Electric and Gas Company, of New Jersey, and occupies the same space as the earlier unit. Increased operating efficiency with this 20,000-kw mercury turbine and boiler installation was reported as a result of the replacement but actual performance was not given.

Spanish Terms for Steam Equipment

In view of the increasing trade between the United States and Spanish-speaking South American countries, involving considerable power-plant equipment, it is believed that the following list of translations will be found helpful in connection with correspondence and the preparation of proposals and specifications. We are indebted to Mellor-Goodwin Soc. de Resp. Ltda., of Buenos Aires for the compilation of these terms as commonly applied to power equipment in those countries.

GENERAL TERMS:

Boiler—caldera
Boiler horsepower—horsepower de caldera
Center—centros
Diameter (inside)—diámetro interior
Diameter (outside)—diámetro exterior
Ductwork (air, gas)—conductos de aire, gas
Evaporation—evaporación
Height—altura
Insulation—aislación
Length—largo
Pressure—presión
Rating—porcentaje de carga
Riveted—remachado
Spare parts—repuestos
Stacks—chimenea
Steam—vapor
Steel plate—chapa de acero
Structural steel—armazón
Supporting steel—armazón de soporte
Superheat—recalentamiento
Total steam temperature—temperatura total de vapor
Turbine—turbina
Welded—soldado
Width—ancho
X-Ray—rayos-X

FUELS AND FUEL-BURNING EQUIPMENT:

Bagasse—bagazo
Coal—carbón (de piedra)
Fuels—combustibles
Gas—gas
Oil—petróleo
Oil burner—quemador de petróleo
Pulverizing mill—molino para pulverizar
Pulverized coal burner—quemador de carbón
Stoker—stoker

STEAM GENERATING UNIT:

Air preheater—precalentador de aire
Access doors—puertas de acceso
Ash hopper—tolva de ceniza
Baffles—diafragmas
Baffle supports—soportes para diafragmas
Boiler—caldera
Casing—revestimiento metálico
Damper and frame—registro y marco
Downtakes—tubos de bajada
Drums—domos
Drum brackets—soportes de domo
Drum head—extremidades curvadas de domo
Drum shell—chapa de domo
Drum internals—partes interiores de domo
Economizer—economizador
Fins—aletas
Forced-draft fan—ventilador tiraje forzado
Furnace—horno
Handholes—entrada de mano
Headers—cabezales
Induced-draft fan—ventilador tiraje inducido
Inspection doors—puertas de inspección
Lugs—orejas
Manhole cover—tapa entrada de hombre
Nozzles—salidas
Risers—tubos de subida
Setting { general—revestimientos / brickwork—mamposteria
Soot blowers—sopladores de hollín
Soot hopper—tolva de hollín
Superheater—recalentador
Tubes—tubos
Tube holes—agujeros de tubos
Tube spacing—distancia entre tubos
Walkways and ladders—plataformas y escaleras
Water walls—cortinas de agua

BOILER SETTINGS:

Firebrick—ladrillos refractarios
Floor—piso
Front walls—paredes frontales
Mortar—cemento
Rear walls—paredes trasero
Red brick—ladrillos comunes
Refractory—refractario
Roof—techo
Setting materials—materiales de revestimiento
Side walls—paredes laterales
Tile—tejuelas

BOILER ACCESSORIES:

Automatic control—regulación automática
Blowoff valve—válvula de purga
Check valve—válvula no retorno
Feedwater regulator—regulador de alimentación
Feed pumps—bombas de alimentación
Feed valve—válvula de alimentación
Gaskets—juntas
High-low alarm—alarma alto y bajo nivel
Instruments—instrumentos
Non-return valve—válvula de no retorno
Safety valve—válvula de seguridad
Steam gage—manómetro de vapor
Water column—columna de agua
Tools—herramientas
Tube cleaner—limpiador de tubos
Tube expanders—mandriles

PIPING:

Piping—caneria
Bends—codos o curvas
Expansion joints—juntas de expansión
Flanged—a brides
Screwed—a rosca
Seamless—sin costura
Bolts—bulones
Nuts—tuercas

AUXILIARY DRIVES:

Fan accessories—accesorios de ventilador
Flexible coupling—cupla flexible
Motor drive—a motor
Motor starter—arranque
Shaft—eje
Turbine drive—a turbina
Wheel—rueda o impulsor

STEAM ENGINEERING ABROAD

As reported in the foreign technical press

Tube Failure Due to Sudden Steam Demand

F. Kaiser, in the *Supplement* to *Die Wärme* of September 1940 describes an unusual failure of water-wall tubes in a German high-pressure boiler due to a sudden large demand for steam. The boiler had been operating with an output of around 44,000 lb per hr at 855 lb pressure and was connected, through an oil-operated reducing valve, with the low-pressure steam main served by three 255-lb pressure boilers. The sudden steam demand was caused by placing a large low-pressure turbine on the line. Apparently the reducing valve opened its full area with a small drop of pressure in the steam line, for within $2^1/_2$ min the output of the high-pressure boiler rose to 66,000 lb per hr and the pressure dropped to 65 lb. The boiler continued to take over the entire load and the pressure continued to fall rapidly to only a few pounds gage.

This rapid pressure drop within the upper drum created a powerful steam release accompanied by priming and consequent steaming in the downcomers which ceased to function as such and to supply the furnace wall tubes. Two of these ruptured, and the remaining nineteen tubes on that wall bent, probably due to overheating.

To verify the assumption that the failure had been due to disturbed circulation, the conditions were reproduced in a model boiler containing a glass riser and downcomer and glass drum ends. A sudden release in pressure by opening the safety valve caused steaming in both the riser and the downcomer and pulsations in the circulation sufficient to involve complete interruptions of flow. It is possible, however, that these pulsations may have been associated with the small tubes of the model and may not have occurred in the actual boiler.

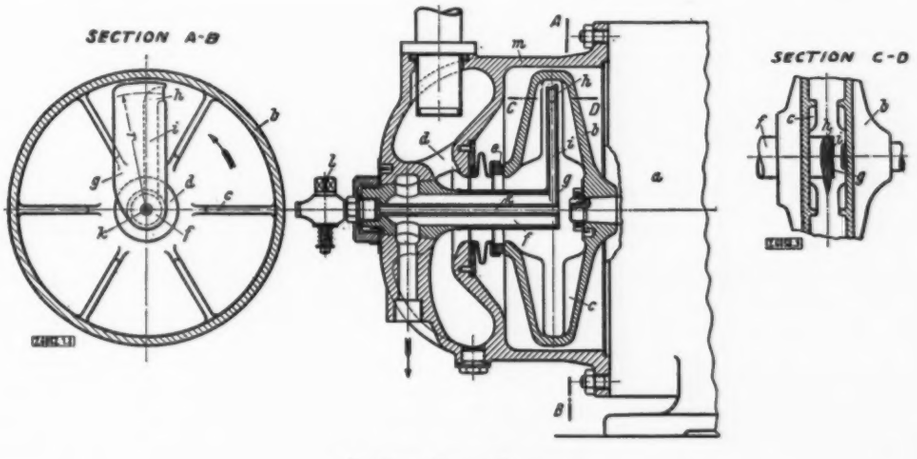
Centrifugal Pump with Rotating Casing

In the *V.D.I. Zeitschrift*, Vol. 84, page 373, Ulrich Barske describes a centrifugal pump having a rotating casing from which the fluid is removed by a stationary body.

Referring to the illustrations, the runner *b* is overhung from the bearings of the driving motor *a* and is provided with ribs *c*. It is sealed at the intake *d* by means of a sliding ring *e*. The pressure discharge pipe *f* is axially located at the center of the intake and carries the stationary body *g*, known as the wing, which removes the fluid. The wing extends radially into the runner and has a streamlined cross-section as shown in Section *C-D*. At its outer end is an opening *h*, directed against the rotation of the runner, which connects through channel *i* into the pressure pipe. Within this pressure pipe is an air-vent tube *k* which may be closed by cock *l*. The outer housing *m* is flange-connected to the motor thereby keeping all parts in alignment.

In operation, the fluid enters at a low velocity into the runner, which is always entirely full, and is revolved by the ribs. The fluid is removed at the periphery of the runner by the wing and delivered thence to the pressure pipe. Air which will collect at the center of the runner may be removed by the vent tube.

Assuming the delivery to be closed, the fluid revolving with the casing and a small offtake hole in the wing, the total pressure measured would be the static plus the dynamic heads at the point of offtake or twice the static pressure due to centrifugal force. In practice the actual pressure falls about 10 per cent short of this, as the fluid does not attain the casing speed at the wing, the entrance condition at the actual offtake differs from that of the small hole and because of the pipe friction losses. The



Section through pump

POSITIVE
Protection

Fig. No. 4114: Yarway Forged Steel Water Column for 900 lbs. pressure. Equipped with Yarway Vertical Gage, Fig. No. 4178, with four-glass steel insert.

Hundreds of leading utilities and industrial plants insist upon Yarway Water Columns to protect their boilers.

Yarway's unique Hi-Lo Alarm mechanism utilizes balanced *solid weights* that are as indestructible and unchanging as the metal itself. Operating on the displacement principle, they literally "weigh the water level."

When the high or low water emergency occurs—instant, positive, powerful, hair-trigger *action* results—giving warning of danger by whistle, light, or both.

Yarway Water Columns, eight standard models, iron bodies with screwed connections for pressures up to 250 lbs., forged steel bodies with flanged connections for pressures up to 1500 lbs., are fully described in Catalog WG-1807. Write for a copy and working model.

YARNALL-WARING COMPANY
101 Mermaid Ave. Philadelphia

YARWAY
FLOATLESS HI-LO ALARM
WATER COLUMN

pump characteristic is then one having, at constant speed, a maximum pressure at no delivery and a falling head with increased delivery. The velocity of flow within the runner is low due to ample area and the runner requires no finishing. The wing is polished smooth at a low cost.

The air vent is important to keep the runner full for maximum pressure. A partially full runner produces a relative increase in power because of the introduction of fluid whirl by the wing which does not occur when full. By placing the wing vertically or by placing the pump horizontally, with the discharge vertically upward, the runner may be easily kept vented.

The article then discusses the structural features of the pump.

Cavitation does not occur and fluids may be handled at high revolutions even near the boiling point. Pressures may be used of from 20 to 50 atm (284 to 710 lb per sq in.) depending upon the rotative speed and a test run was made up to 80 atm (1140 lb per sq in.) using but one stage. This could be increased by further staging. As with other types of pumps the efficiency is low when delivering small quantities of fluid. An experimental pump of from 3 to 15 cu m per hr (106 to 530 cu ft per hr) disclosed that an efficiency comparable with those of other centrifugal pumps may be attained. The most favorable pressures for this pump were from 8 to 10 atm higher than for an equivalent single-stage centrifugal pump. The pump thus occupies a field where the usual centrifugal pump requires several stages.

Sizing of Coal on Traveling Grate

R. Schulze and H. Janissen in *Die Wärme* (Vol. 63, p. 61) report the results of a series of tests with different sizes of semi-bituminous coal on a traveling-grate stoker under a Steinmuller straight-tube boiler operating at 425 lb pressure. The coal used was of the non-caking variety, had a heating value of 13,300 to 13,800 Btu per lb and averaged about 15 per cent volatile. The highest efficiency, namely 86.9 per cent, was obtained with $^1/_8$-in. to $^1/_4$-in. slack whereas an efficiency of only 82.9 per cent was obtained with 1 in. to $1^1/_4$ in. nut. With this larger size the unburned carbon in the ash was nearly double that with the smaller size. It was also concluded that re-screening to obtain $^5/_8$-in. to $^3/_4$-in. coal resulted in no marked improvement over the average run of $^7/_{16}$-in. to 1-in. size.

Control of British Electricity Supply Construction

Engineering (London) reports that the Electricity Commissioners have drawn attention to a new regulation which provides that, subject to certain specified exceptions, the execution in the United Kingdom of any building or constructional operation for the carrying on of an electricity supply undertaking shall be unlawful unless authorized by the Commissioners. Exceptions apply where such construction is undertaken under a government contract or where the cost is wholly or partly borne by a government department, or by a local authority under the Civil Defense Acts, if commenced before October 7, 1940.

Power Production in Japan

Writing in the October issue of *The Far Eastern Review*, Toshiyé Obama reviews the growth of the electrical industry in Japan. Figures for the last three years are not available as the authorities have not permitted the publication of such statistics since the start of the present campaign in China, but the figure for 1937 was 7,276,000 kwhr and in the ten years from 1927 to 1937 the annual production of electricity increased 110 per cent. Since then the production has been stepped up greatly due to the demand by munitions industries.

Of the total power produced in 1937, both public and private, 55 per cent was generated by water power and 45 per cent by fuel. The power companies produced 85 per cent of the total, and private industrial plants only 15 per cent. Of that furnished by the utilities 68 per cent was generated by hydro and 32 per cent by fuel. It is pointed out that at present the entire electrical industry in Japan is operated under rigid state control.

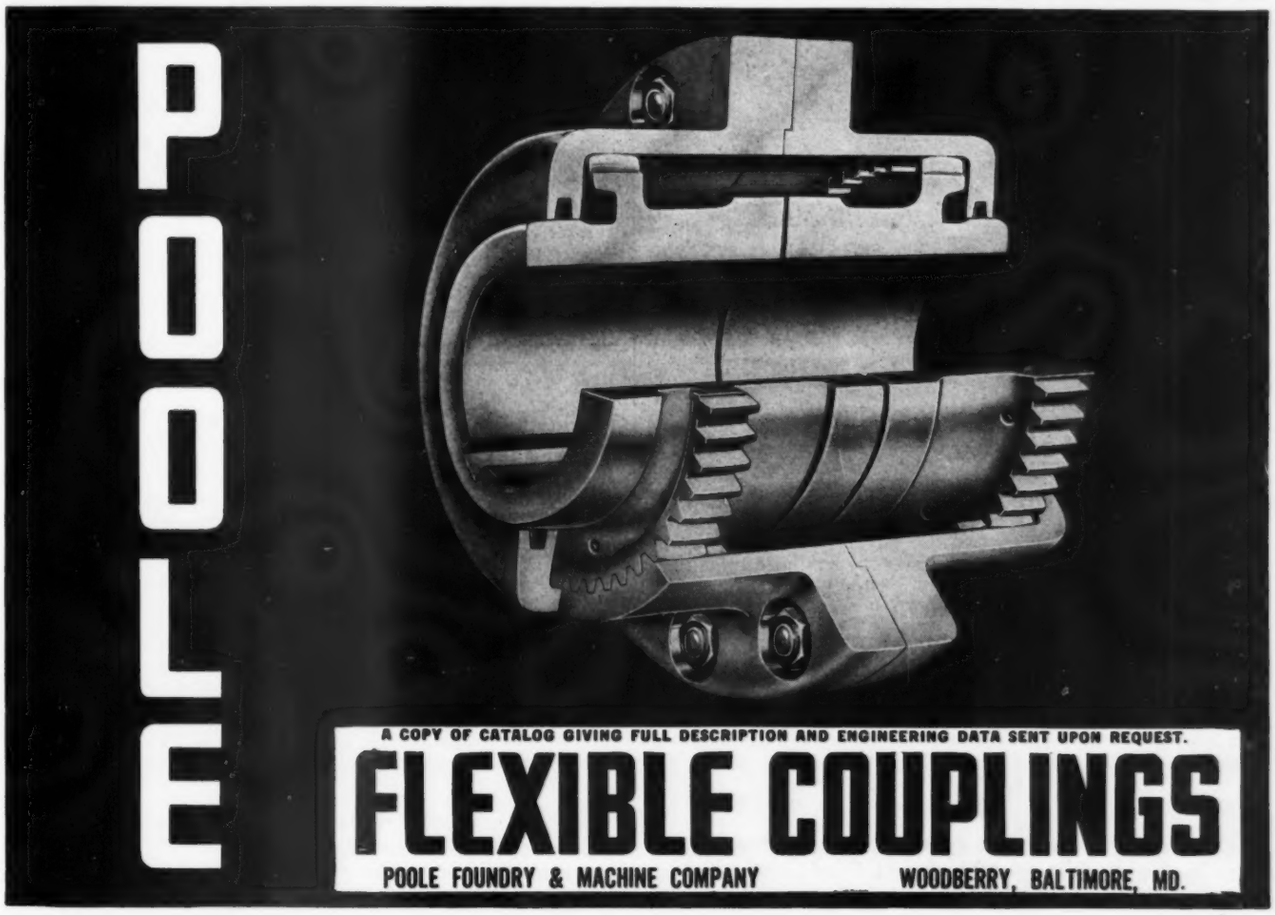
Pump Materials for High Steam Temperature

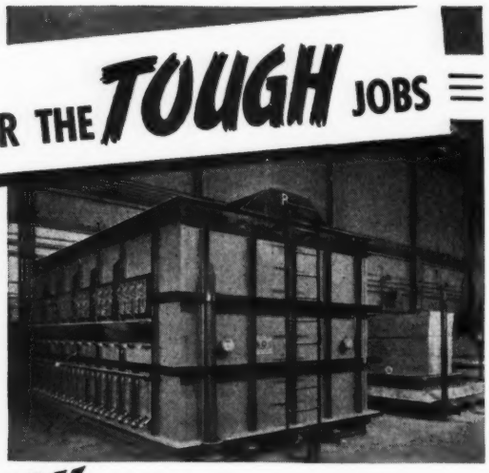
An article on "Metallurgical Progress" by L. Sanderson in *The Steam Engineer* (London) of December comments on the selection of material for castings operating with superheated steam, particularly as pertains to cylinders of steam pumps. It states that a nickel-chromium cast iron is suitable for temperatures up to 590 F. Above this, allowance must be made for weakening of the metal over long periods of use. Where temperatures up to 850 F are encountered, this material may be employed when correct allowance has been made for creep and the resulting differences in dimensions incident to creep and growth combined. For very high steam temperatures it is advisable to subject the castings to annealing at 1000 to 1100 F. For steam temperatures in excess of 900 F steels of the creep-resisting type are commonly used, although nickel-chromium iron linings such as sleeves or threaded bushings have been used when backed up by the steel, principally because of their resistance to seizing.

Pulverized Coal in Engine Cylinder

The burning of pulverized coal in cylinders of internal-combustion engines has long been the subject of experimental work, chiefly in continental Europe, but wear on cylinder liners, pistons, rings and valves has proved an obstacle to commercial success. Further investigations of this character by the British Fuel Research Board are reported in *Engineering* of December 6.

In these experiments one cylinder of a Mirrlees diesel engine was converted to pulverized coal operation by the substitution of a coal-dust injection valve and precombustion chamber for the original fuel oil valve, and the addition of a new valve lever and coal hopper; but the original cylinder head was retained. By using a chromium-plated liner in conjunction with an ordinary cast-iron piston and rings, the liner wear was reduced to about one-seventieth, the top ring wear to one-sixtieth and the piston wear to about one-thirtieth of that encountered with cast-iron liner, piston and rings.


POOLE
A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.
FLEXIBLE COUPLINGS
POOLE FOUNDRY & MACHINE COMPANY
WOODBERRY, BALTIMORE, MD.



Carey MAGNESIA • ASBESTOS HEAT INSULATIONS

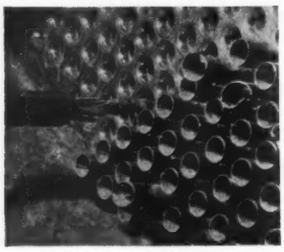
At the plant of the Otis Steel Company, Cleveland, steel sheets to be annealed are stacked on bases and covered with corrugated steel hoods. Gas furnaces are then swung over the hoods.

In these annealing operations, the bases are subjected to extreme heat and heavy loads. In previous experience, the bases broke down after 50 heats—had to be rebuilt. Since rebuilding with CAREY HI-TEMP and 85% MAGNESIA, the bases are as good as new after 50 heats.

The tougher the job, the more you need CAREY Insulations. Whatever your insulation problem, put it up to CAREY. Write for Insulation Catalog—address Dept. 69.

THE PHILIP CAREY COMPANY • Lockland, Cincinnati, Ohio
Dependable Products Since 1873
BRANCHES IN PRINCIPAL CITIES

Save on CONDENSER REPAIRS in 3 Ways



Corroded tube ends stretched beyond the tube sheet. These will be cut off by the C & C Tube Cutter and the tubes rerolled into the tube sheet as good as new.

- STRIP CONDENSER TUBES FASTER
- STRETCH TUBES FOR LONGER SERVICE
- CUT OUTAGE TIME TO A MINIMUM

by the

C & C METHOD

Now you can pull old tubes from condensers and heat exchangers at the rate of 15 a minute and get higher scrap value for discards—by using the C & C Machines and Service. You thus save up to 80% in time.

By means of the C & C Tube Stretching Method you can keep old tubes in service for many more years by stretching worn or corroded tube ends, without removing tubes from the condenser.

C & C Condenser Renovation Service has saved thousands of dollars on repairs in power plants everywhere. Let us show you the record. . .

Write for Bulletin No. C-41

C & C CORPORATION

383 Fourth Avenue New York, N. Y.

EQUIPMENT SALES

Boiler, Stoker, Pulverized Fuel

as reported by equipment manufacturers to the Department of Commerce, Bureau of the Census

Boiler Sales

	1940 Water Tube		1939 Water Tube		1940 Fire Tube		1939 Fire Tube	
	No.	Sq Ft*	No.	Sq Ft*	No.	Sq Ft	No.	Sq Ft
Jan.....	62	285,042	75	427,658	51	68,639	50	64,511
Feb.....	54	386,356	70	340,559	47	51,474	45	58,028
Mar.....	56	438,980	98	484,220	51	58,529	58	54,752
Apr.....	89	476,135	62	301,875	56	50,356	36	42,177
May.....	101	663,721	104	447,722	75	84,094	74	96,037
June.....	150	814,210	99	538,736	110	122,026	52	58,793
July.....	111	632,373	88	345,834	89	128,784	59	66,595
Aug.....	118	685,212	88	426,206	90	108,680	52	55,714
Sept.....	145	944,970	136	821,849	63	65,218	74	110,082
Oct.....	127	696,993	118	659,955	106	124,876	58	71,060
Nov.....	155	992,046	80	580,218	78	93,593	66	75,318
Jan.-Nov. Inclusive	1,168	7,016,038	1,018	5,374,832	816	956,269	624	753,067

* Includes water wall heating surface.

Mechanical Stoker Sales†

	1940 Water Tube		1939 Water Tube		1940 Fire Tube		1939 Fire Tube	
	No.	Hp	No.	Hp	No.	Hp	No.	Hp
Jan.....	24	10,770	44	17,067	104	14,745	145	17,842
Feb.....	31	10,729	46	20,715	118	17,862	140	18,217
May.....	35	17,460	46	19,068	76	12,717	122	15,743
Apr.....	36	14,554	50	18,888	89	15,123	114	13,652
May.....	73	30,930	62	29,245	88	11,402	153	20,010
June.....	65	16,772	83	34,618	152	21,636	184	21,801
July.....	86	31,199	66	20,893	189	27,227	213	30,780
Aug.....	78	26,202	65	22,589	274	32,209	311	41,310
Sept.....	81	39,799	94	40,983	305	41,038	345	45,731
Oct.....	92	38,107	63	23,480	315	42,157	313	39,784
Nov.....	67	22,107	58	24,307	182	23,300	208	27,428
Jan.-Nov. Inclusive	668	258,629	677	271,853	1,892	259,416	2,248	292,298

† Capacity over 300 lb of coal per hr.

Pulverizer Sales

	1940 Water Tube			1939 Water Tube			1940 Fire Tube			1939 Fire Tube		
	No.		Lb	No.		Lb	No.		Lb	No.		Lb
	N.‡	E.‡	Coal/Hr	N.‡	E.‡	Coal/Hr	N.‡	E.‡	Coal/Hr	N.‡	E.‡	Coal/Hr
Jan.....	10	—	214,250	10	—	79,000	1	—	600	—	—	—
Feb.....	15	1	186,935	7	—	89,600	1	2	2,800	—	—	—
Mar.....	17	2	331,800	27	—	501,560	—	—	—	—	—	—
Apr.....	26	5	270,500	8	—	155,050	—	—	—	—	—	—
May.....	30	5	447,450	19	—	401,800	—	—	—	—	3	1,800
June.....	21	2	360,270	16	1	243,230	—	—	—	—	—	—
July.....	25	2	570,400	6	—	43,770	—	—	—	—	—	—
Aug.....	37	—	705,860	3	5	103,700	—	—	—	—	—	—
Sept.....	37	3	1,208,960	33	11	556,430	1	—	2,800	1	—	1,250
Oct.....	26	3	405,430	28	2	471,410	—	—	—	1	—	2,800
Nov.....	48	—	622,480	22	—	385,750	—	—	—	—	3	3,750
Jan.-Nov. Inclusive...	292	23	5,324,335	179	19	3,031,300	3	2	6,200	2	6	9,600

‡ N—New boilers; E—Existing boilers.

NEW CATALOGS AND BULLETINS

Any of these publications will be sent on request.

Automatic Control Equipment

Engineers and plant operators interested in automatic combustion control, automatic control of pressure, turbine speed, temperature, etc., will want a copy of this new booklet, "Stability in Automatic Control Equipment," published by the Askania Regulator Co. It is a comprehensive treatise that discusses the causes and the evils of "hunting," the overshooting and undershooting that often result when a time lag is introduced. It shows how the limitations of many methods of automatic control cannot satisfactorily defeat this "hunting." Most important, it shows how the problem can be corrected basically, how true stability can be attained, without any sacrifice of sensitivity. The text of the booklet is illustrated generously with simple, easy-to-follow diagrams.

Baffles

The Engineer Company announces a new 8-page bulletin BW-40 showing the modern practice in baffle walls. There is a short illustrated description of the progress made in baffle design and construction for straight and bent-tube boilers during the past 25 years, and a résumé of the introduction of streamline baffles, together with construction details, available service, applications and a partial list of installations.

Blanket Insulation

Refractory and Insulation Corporation has released a new bulletin No. I-64 describing mineral-wool laminated blanket insulation. In its six pages the bulletin describes and illustrates the various applications and includes information as to standard types and sizes, list prices, methods of application and selection of proper thickness of insulating blankets. There is a chart of comparative heat conductivities as well as a list of equipment for which the blankets are used extensively.

Dust Collection

In a 24-page booklet, Buell Engineering Company, Inc., presents the story of the control and collection of dust in industry. The first 14 pages are devoted to representative installations, origin of dust, applications, testing and certain processes requiring specially designed collectors. The remaining ten pages are devoted to explanation of the Van Tongeren theory, particle size, screening, air elutriation, efficiency and the effect of dust concentration on apparent collector performance. The booklet is profusely illustrated throughout and is attractively arranged.

Electric Eye for Combustion Control

Bulletin No. 10 issued by Brooke Engineering Company describes its system of automatic combustion control which is based on use of an "electric eye" to measure the light density of the products of combustion. This light density measurement is converted to impulses which change the rate of air flow in proportion to load requirements through the medium of an electronic relay which, by means of standard radio tubes and thyraton tubes, amplifies the impulses received from the electric eye.

In addition to describing the apparatus in detail, the bulletin contains a diagram showing the control circuits for a typical pulverized-coal installation and charts are reproduced showing the effectiveness of the control in one of a number of applications to representative industrial power plants.

Electric Flow Meters

A new catalog No. 2007 has recently been published by The Brown Instrument Company. The catalog covers its complete line of electric flow meters for the measurement and control of steam, air, oil, water, chemicals and other fluids. Schematic diagrams of the various meter bodies and piping layouts are shown. Design features including rectangular case, automatic recording planimeter pen, interrelated range tubes, etc., and the operating principle of the meters are fully described.

Exhaust Heads

The Cochrane exhaust head is said to insure the separation of condensate and oil from steam discharged to atmosphere and thereby prevent raining of water and oily condensate upon the roof or ground below, at the same time discharging clean, dry steam noiselessly.

The new exhaust head incorporates the principles of the baffle-type steam separators used for removing oil and moisture from steam lines. Exceptional port area produces low steam velocity and minimizes pressure loss. Steam is whipped sidewise after passing through the port and causes projection of entrainment against ribbed baffle surfaces. The high ribbed baffles exert a scrubbing action in addition to the centrifugal purging force. The exhaust head is of one-piece, semi-steel construction for 4-to 12-inch sizes and of welded plate for larger sizes. Publication 2960 contains complete engineering data, dimensions and list prices.

Hot-Process Water Softeners

The Permutit Company has recently issued a 32-page comprehensive treatise, Bulletin No. 2341, on hot lime-soda water softening. It describes five types of deaerating and non-deaerating heaters, namely, those applicable to (1) plants requiring deaeration and softening of substantially 100 per cent makeup; (2) low-pressure plants, under 300 lb, and requiring softening of 100 per cent makeup; (3) plants where condensate returns represent more than 70 per cent of boiler feed and which required deaeration; (4) those in which condensate returns represent less than 70 per cent of boiler feed and which required deaeration; and (5) low-pressure plants where condensate returns are available and require softening and heating of the condensate. Filters and electrochemical feed are included.

The bulletin is fully illustrated and contains numerous diagrams of flow and connections.

Insulating Firebrick

An eight-page folder containing technical data on the A. P. Green line of insulating firebrick has recently been released. The folder contains suggestions for selection of the best brick, descriptions, thermal conductivity, spalling resistance, effect of reducing atmospheres, thermal expansion, physical strength and test data of the various grades.

Liquid-Level Meters

A new 8-page bulletin, No. 2990, covering six different styles of mechanically- and electrically-operated liquid-level meters has recently been published by Cochrane Corporation. Four electrically-operated types particularly designed for remote service, including float, differential pressure, and bourdon spiral systems, are included in the bulletin. Application drawings and technical data are conveniently arranged in sections devoted to each of the various available instruments. A liquid-level meter serves to provide records that supplement those of fluid flow, pressures, temperatures, etc., and is said to enable the owner to obtain the complete facts with regard to operating conditions and performances of main equipment and processes.

Oil Cooler

The Condenser Service and Engineering Company, Inc., has issued an 8-page Lubricating Oil Cooler folder, No. 31. It contains illustrations and tables which give dimensions, weights, capacities and pressure drops, together with cooling surface and code numbers. The coolers are of simple design such as to enable any

operator to perform all the necessary dismantling and cleaning work. Removal of the two heads gives complete access to both tube sheets and tube ends for cleaning.

Oil Burners, Pumps and Heaters

The Engineer Company announces the publication of a four-page folder describing the Enco fuel oil burning, pumping and heating systems. It contains specifications, illustrations, some details of the integral parts of the equipment and a partial list of installations.

Plant Preparedness

A 12-page booklet entitled "Put Your Plant on a Preparedness Basis" has been published through the combined efforts of Hagan Corporation and Hall Laboratories, Inc. It brings to light some of the difficulties experienced by power plant operators during the hectic days of the World War, as a result of demands for maximum output from units that were not in the "pink of condition." Today's plants can be modernized and made to operate efficiently now; tomorrow, the booklet says, the men needed to effect this modernization may be working for *Uncle Sam*.

Pumps and Pump Parts

A new illustrated booklet containing comprehensive information on pumps and pump parts, published by The International Nickel Company, has just come from the press. This 16-page folder, "Practical Pumping Problems and How They Are Solved," discusses in detail the uses of Monel, "K" Monel and "S" Monel for pump parts in applications where there is need for high resistance to corrosion, wear, pitting or scoring. This includes different types of pumps, such as reciprocating, centrifugal and rotary pumps.

Part of the book is devoted to a review of case histories. Complete performance data are given on pumps in various applications which suggest how sizable savings can often by made in maintenance and replacement costs. Much attention is given to the choice of suitable materials for pumps handling a variety of corrosives in a wide range of industries, including power, chemical, municipal water supply, processing, railroad, steamship operation and other diversified fields. The booklet, which is of a semi-technical nature, is being distributed without charge.

Refractories

"World-Wide Refractories Service" is the title of a 48-page export booklet just issued by General Refractories Company. This book is printed in both English and Spanish, contains color throughout and has sixty-five illustrations in addition to thirty technical drawings of brick shapes and sizes. It covers descriptive information on all the major types of refractories and their uses, describes methods of shipment for export and incorporates ten pages of such tables of sizes, weights, volumes and general data as are usually required in the use, application and purchase of refractories.

Silica Removal

After several years of research, The Permutit Company reports a process for removing silica from high-pressure boiler feedwater. It is said to be commercially perfected and in successful operation. The bulletin, No. 2377, describes the "Mag-de Sil" process in detail and shows how the silica content of any water can be reduced to any value using moderate amounts of low cost reagents which do not add soluble by-products. It also shows how this process can be adapted to either hot or cold lime soda treatment and applied to either new or existing equipment.

Thermometers and Pressure Gages

The Brown Instrument Company has recently published its Catalog No. 6706 illustrating and describing rectangular case thermometers and pressure gages. The pressure type thermometers employ a bulb and capillary tubing system and are applicable for temperatures ranging from −40 F to +1200 F. The bulb location can be any distance up to 200 feet from the instrument. Pressure gages are available for operating pressures ranging from 30 in. Hg vacuum to 10,000 lb per sq in.

Temperature Instruments

Micromax temperature instruments for electric power equipment are described in a new 32-page illustrated catalog, N-33-161, just issued by Leeds & Northrup Company. Written for those concerned with the operation of generators, synchronous condensers, frequency changers, large motors, transformers and cables, this publication shows how knowledge of operating temperatures enables operators to act promptly, at the first sign of a rise, to protect units against overheating and provides a reliable guide for maximum safe loading. The Micromax recorders it describes are said to prevent loss in plants by providing automatic and continual temperature checks at selected points in power units, and by sounding alarms if temperature at any point exceeds safe limits.

Valves

A 240-page letter-size cloth-bound catalog on valves, pipe fittings and fire hydrants, recently published by The Kennedy Valve Manufacturing Company, is an exceptionally complete presentation of data on bronze and iron-body valves for low, standard and higher pressures, standard bronze and malleable-iron screwed fittings, standard cast-iron flanged fittings and flanges, fire hydrants and various valve specialties.

The catalog has many illustrations, and has several features for convenience in use: in the section on iron-body valves, dimensions and prices of valves and accessories are all on facing pages, thereby minimizing cross references to other pages.

A section of the catalog is devoted to descriptions of valve accessories for various operating conditions. Other features of the catalog are recommendations for the selection of valves and fittings, suggestions for operation, care and maintenance of valves, and much useful engineering data. Indexes and tabulations of references on pages of listings and dimensions facilitate the use of the catalog in finding desired information.

ABSENCE OF PULSATION *IMPROVES* COMBUSTION

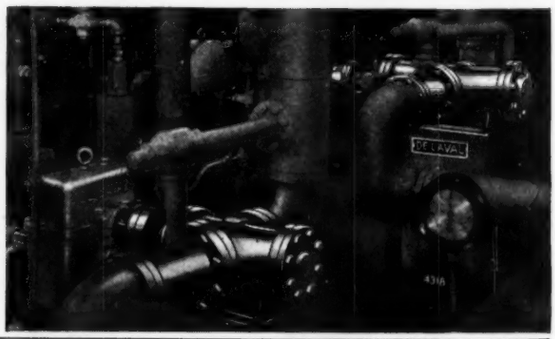
The De Laval-IMO pump favors better combustion by delivering oil to burners uniformly. Its action is like that of a continuously acting piston. There are no valves and no reciprocating parts, nor do the rotors trap oil. The moving members (3) are in perfect rotational balance.

The two geared turbine driven IMO pumps here shown each supplies 90 g. p. m. of Bunker C against 250 lb. pressure to burners on 24-hour service in a central station.

De Laval-IMO pumps are available in all sizes and for all pressures and to handle any grade of oil, from light Diesel to heavy Bunker C. Ask for Publication I-65.

IMO MOVES OIL

IMO PUMP DIVISION
of the De Laval Steam Turbine Company
Trenton, New Jersey



Some Large Turbine Units

Last year was marked by the large number of turbine-generators ordered for capacities ranging from 50,000 to 80,000 kw. A few exceeded the latter figure, the largest being a 100,000-kw, 1200-lb, 950-F, 3600-rpm quadruple-flow G.E. machine which went into service at Burlington, N. J., in November. An 85,000-kw unit was ordered for the Cabin Creek (W. Va.) station and the largest single-casing, single-flow turbine, of 80,000 kw capacity operating at 1250 lb, 900 F, 1800 rpm, went into service at the new Oswego Station of the Central New York Power Corp., for which a second duplicate unit is now under construction.

Other 80,000-kw machines include one for the Buck Station of the Duke Power Company, one for the Huntley Station at Buffalo, and a single-cylinder low-pressure Westinghouse unit for the Chester Station of the Philadelphia Electric Company. The largest 3600-rpm condensing turbine yet ordered is one of 75,000 kw maximum output for the Wilmington Station of the City of Los Angeles to supplement Boulder Dam power. A third 75,000-kw single-casing, single-flow condensing turbine-generator to operate at 815 lb, 900 F, 1800 rpm, was ordered for the Delray Station, Detroit.

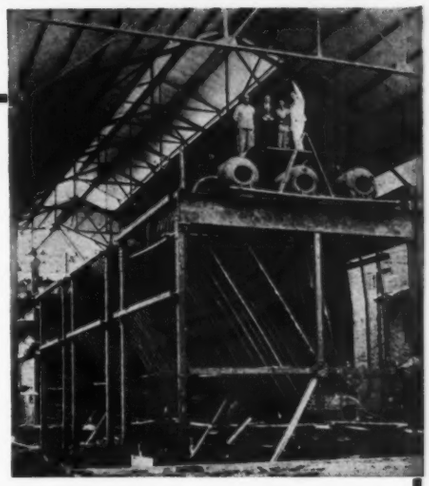
Units of 65,000 kw capacity were ordered for the Waterside Station (New York) and the Columbia Park Station, near Cincinnati, and 60,000-kw units were ordered by the Cleveland Electric Company, the Georgia Power Company and the TVA for its new steam plant near Chattanooga. A number of machines of 50,000 kw and under are also being built for central station service, both topping and condensing.

Personals

J. E. Tobey, vice president in charge of engineering for Appalachian Coals, Inc., has been appointed by Governor Brincker of Ohio as a member of the State Board of Registration for Engineers and Surveyors. Mr. Tobey received his education at Michigan State College and at the U. S. Naval Academy and was senior engineer officer on one of the battleships during the World War. Later he was for 15 years chief engineer of power plants for the Studebaker Corporation.

S. J. Horrell has lately been appointed vice president of the Power Piping Division of Blaw-Knox Company and Harry Gay chief engineer of that division. Previous to joining Blaw-Knox, Mr. Gay had been associated with Stone & Webster, Sargent & Lundy, Day & Zimmermann and other engineering firms in the power plant field and in pulp and paper processing.

C. D. St. Clair has been appointed works manager of the Hancock Valve Division of Manning, Maxwell & Moore, Inc. In the 22 years since receiving his engineering education at Purdue University and at Pennsylvania State College, Mr. St. Clair has been associated with several large industrial organizations and for the last 15 years has been with his present company in various capacities.



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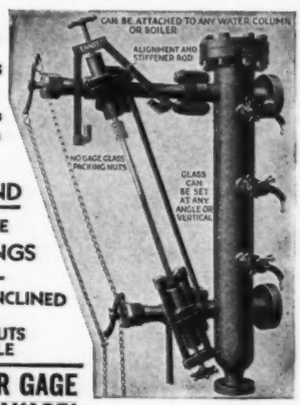
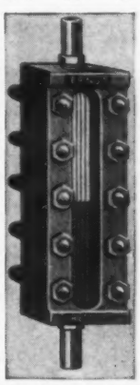
NO HOT NUTS TO HANDLE


CAN BE ATTACHED TO ANY WATER COLUMN OR BOILER
ALIGNMENT AND STIFFENED ROD
NO GAGE GLASS PACKING NUTS
GLASS CAN BE SET AT ANY ANGLE OR VERTICAL

C-BLACK REFLEX GAGE GLASS INSERTS



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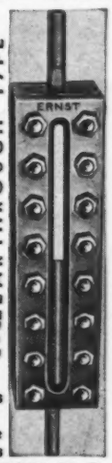
STOP YOUR GAGE GLASS BREAKAGE!

HIGH PRESSURE GAGE GLASS GASKETS "They won't blow out"

Send For Washer Chart

ERNST SUPERIOR WATER COLUMN EQUIPMENT FOR ALL PRESSURES AND TEMPERATURES



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LEAKLESS COCKS

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